Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

ALBION REED HODGDON, Editor-in-Chief

ROLLA MILTON TRYON
RADCLIFFE BARNES PIKE
STEPHEN ALAN SPONGBERG
GERALD JOSEPH GASTONY
ALFRED LINN BOGLE
} Associate Editors

Vol. 75 **March, 1973** **No. 801**

CONTENTS:

Chemical, Cytological and Genetic Evidence for the Hybrid Origin of Aster blakei (Porter) House
L. Michael Hill and *O. M. Rogers* 1

Chromosome Numbers in Asters
Paul Van Faasen and *Fern Frank Sterk* 26

The Northern Limits of the Distributions of Hickories in New England
Wayne E. Manning 34

Benthic Algae and Vascular Plants of the Lower Merrimack River and Adjacent Shoreline
Arthur C. Mathieson and *Richard A. Fralick* 52

Some Morphological Aids in Distinguishing Nuphar microphyllum from Similar Aquatics
Johonet C. Wicks 65

(Continued on Inside Back Cover)

The New England Botanical Club, Inc.
Botanical Museum. Oxford St., Cambridge. Mass. 02138

RHODORA. — A quarterly journal of botany, devoted primarily to the flora of North America and floristically related areas. Price $10.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes, and single copies are available. For information and prices write RHODORA at address given below.

Scientific papers and notes, relating directly or indirectly to the plants of North America, will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. All manuscripts should be double-spaced throughout. Please conform to the style of recent issues of the journal. Illustrations can be used only if the cost of engraver's blocks is met through the author or his institution. Forms may be closed five weeks in advance of publication. Extracted reprints, if ordered in advance, will be furnished at cost.

Address manuscripts and proofs to Albion R. Hodgdon,
Dept. of Botany, Nesmith Hall, University of New Hampshire,
Durham, New Hampshire 03824

Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of March, June, September or December.

Second Class Postage Paid at Boston, Mass.

MANUFACTURED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Vol. 75 March, 1973 No. 801

CHEMICAL, CYTOLOGICAL AND GENETIC EVIDENCE FOR THE HYBRID ORIGIN OF ASTER BLAKEI (PORTER) HOUSE[1]

L. MICHAEL HILL AND O. M. ROGERS

The genus *Aster* is large and polymorphic, and many authors have cited the taxonomic complexity of this group (Anderson, 1929; Shinners, 1941; Rosendahl & Cronquist, 1949). Fernald (1950) suggested that some of the variation causing this complexity was due to hybridization, and this was anticipated by Wetmore & Delisle (1939), and verified by Avers (1953a), and Uttal (1962). The work of Avers on asters of the Heterophylli series demonstrated that many species could be crossed in cultivation, producing hybrids (Avers, 1953a). However, she noted the absence of such crossing in natural populations. She observed that the barriers to hybridization in nature were primarily ecological, relating to the absence of hybrid habitats (Avers, 1953b).

A recent study by Pike (1970) presented morphological and geographical evidence indicating that *Aster Blakei* (Porter) House was of hybrid origin from *A. acuminatus* Michx, and *A. nemoralis* Ait. The morphological data fur-

[1]Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 442.

The work represents research done by the senior author in partial fulfillment of requirements for the Ph.D. degree.

ther indicated that introgression might be occurring in the direction of *A. nemoralis.*

This paper considers further the origin of *A. Blakei,* utilizing cytological, genetic and chemical techniques. The chemical studies were conducted using thin-layer chromatography of phenolic compounds. These compounds were used as markers in detecting natural hybridization. The genetic techniques involved crosses and backcrosses of the putative parents, *A. acuminatus* and *A. nemoralis.* Self-pollinations also were made to synthesize an F_2 population. The cytological approach involved studies of mitotic chromosomes of the parental taxa and the F_1 hybrid, including specimens of *A. Blakei* cultivated in the greenhouse. Pollen stainability of the parents, F_1 hybrids, backcrosses and F_2 hybrids also were observed.

The application of analytical chemistry to taxonomic studies has been increasingly successful as techniques have become more refined. The work of Turner & Alston (1959) and Alston & Turner (1962) on hybridization in *Baptisia* started the recent emphasis in chemotaxonomy. The species specific compounds of two putative parents in this genus both appeared in suspected hybrids. This has become a principle of phenolic biochemical systematics: the phenolic compounds found in hybrids represent a summation of the species-specific phenolic compounds found in the parents (Alston, 1965 and Harborne, 1968). Utilizing this principle, other workers have confirmed hybridization in various genera. For examples, see Smith & Levin (1963) in *Asplenium,* Jaworska & Nybom (1967) in *Saxifraga,* Olden & Nybom (1968) in *Prunus,* Fahselt & Owenby (1968) in *Dicentra,* and Walker (1969) in *Petalostemon.* The technique has been useful in demonstrating introgression in *Iris* (Carter & Brehm, 1969) and in confirming an instance of intergeneric hybridization (Crang & Dean, 1971).

Very few chemosystematic studies in *Aster* have been published to date. A preliminary survey of phenolics by Turner & Mabry (1964) on various members of the Asteraceae cited only one species of *Aster.* The research of Abra-

hamson & Solbrig (1970) revealed no species-specific phenolics in the Heterophylli series and the authors advised against the use of phenolics in taxonomic considerations of this group. There have been no attempts to consider hybridization in Aster from a chemical point of view.

SELECTION AND MORPHOLOGICAL ANALYSIS OF COLONIES

Living material of *A. acuminatus* and *A. nemoralis* was provided by Dr. Pike from natural habitats in eastern Maine and brought to the greenhouse at the University of New Hampshire in the autumn of 1969. Specimens of *A. Blakei* were collected by the senior author near the southern shore of Lake Ossipee in New Hampshire during the same season. The specimens were potted in a mixture of peat and vermiculite and placed in a house maintained at 24° C. When cold treatment was necessary, the plants were moved to a room maintained at 10°C. This treatment was applied from late November to mid-January of each year.

Specimens subjected to morphological and chemical analysis were collected from three main areas. The first collection of twenty-five specimens came from the southern shore of Lake Ossipee in New Hampshire. A second collection of sixteen plants came from the southern shore of Lake Winnisquam in New Hampshire. A final collection of fifty-four plants came from Great Wass Island in Washington County, Maine. This latter collection consisted of a total of fourteen specimens of *A. nemoralis* and *A. acuminatus* in discrete colonies and forty specimens of *A. nemoralis, A. Blakei* and *A. acuminatus* collected at Ponds Point on the eastern tip of the island facing the Gulf of Maine. *Aster acuminatus* was collected from colonies in a wooded area of high elevation. *Aster nemoralis* was collected from colonies in a small bog in the center of the island. These asters are clonal. Their stoloniferous habit is a characteristic of the species (Fernald, 1950). The clones at Lake Ossipee and Lake Winnisquam were well defined. One ramet was sampled from each clone at these locations. The clones were

not well defined at Great Wass Island. Sampling at this location was based on morphological diversity throughout the area of the population. The plants collected were all scored utilizing the hybrid index described in detail by Pike (1970).

The morphological analyses of specimens collected from these sites are summarized in Figure 1. Plants scoring 0-4 were designated as *A. nemoralis*, 8-19 as *A. Blakei* and 25-30 as *A. acuminatus* (Pike, 1970). The population at Lake Winnisquam was essentially a variable population of *A. Blakei* (Figure 1a). The population at Lake Ossipee indexed as *A. nemoralis* or *A. Blakei* (Figure 1b). The populations at Great Wass Island contained the parental taxa in discrete colonies (Figure 1c), and all three taxa together in a local population at Ponds Point (Figure 1d). Figure 1e summarizes the data in Figures 1c and 1d.

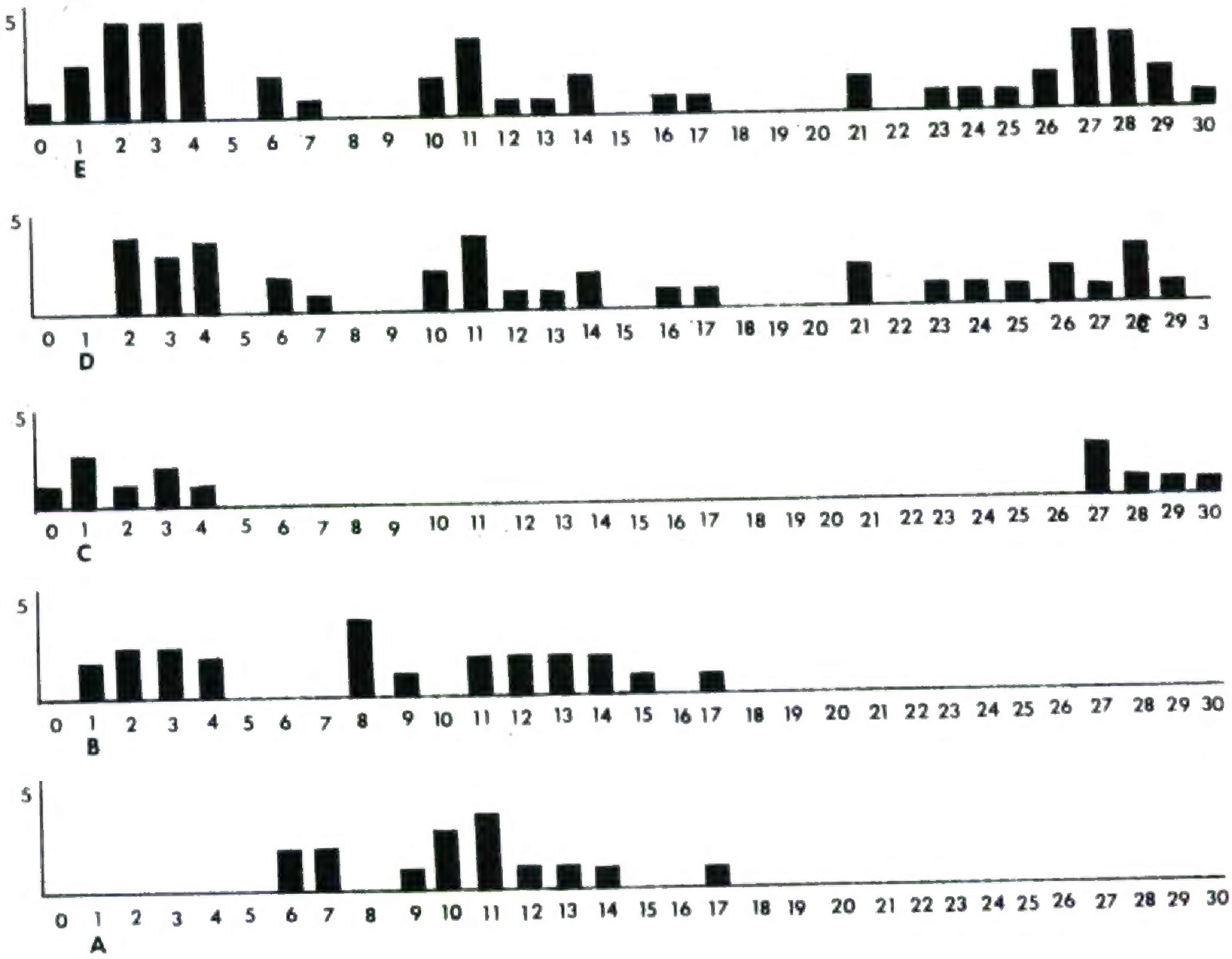


Fig. 1. Morphological hybrid index of Asters at (a) Lake Winnisquam (b) Lake Ossipee and (c, d, e) Great Wass Island.

CHEMICAL DETECTION OF HYBRIDIZATION AND INTROGRESSION

For chemical analyses, fresh basal leaves were shredded at the collection site into 10 ml. of methanol containing 1% 1N HCl. The extracts were stored in the dark for 48 hours at room temperature and then concentrated to approximately 1 ml. by evaporation with the aid of a hand dryer. Paper chromatography gave poor resolution in a comparative test with thin-layer chromatography. In contrast, thin-layer chromatography required only a small amount of extract and gave excellent resolution. The aluminum-backed thin-layer plates were prepared by EM Reagents Division, Brinkman Instrument, Westbury, New York.

Ten microliters of the sample were spotted on one corner of a cellulose plate and chromatographed in the first dimension for 6-8 hours with n-butanol, glacial acetic acid and water (6:1:2). After drying overnight, the plate was chromatographed for 2-2 1/2 hours in the second dimension with 10% acetic acid containing 0.1% sodium acetate. After drying, the plate was viewed under visible and ultraviolet light. Colors of each spot under both conditions were recorded. These colors were again recorded after exposure to ammonia vapor. The plates were subsequently treated with spray reagents recommended by Block, *et al.*, (1958) to distinguish among spots and to determine if these were phenolics. The sprays were: 1% alcoholic ferric chloride; 1% aqueous basic lead acetate; 1% aqueous lead acetate; 1% aqueous sodium carbonate; 1% alcoholic aluminum chloride and Benedicts reagent. Also, diazotized sulfanic acid was applied according to the specifications of Smith (1960). It was discovered that 1% aqueous lead acetate gave good distinctive colors under longwave ultraviolet light. Each spot was labeled with a number for identification on the basis of color of fluorescence, color reactions and position on the plate. The relative location of each spot to each other also was used as a criterion of identification. No attempts were made to determine the chemical structure of these compounds.

A premliminary survey of the phenolics present in the leaves of *A. nemoralis*, *A. acuminatus* and *A. Blakei* collected by Pike and the senior author revealed differences between the number of phenolics at various developmental stages (Hill, 1972). This source of variation was eliminated by studying the phenolics only at the time of full flowering.

Chromatographs of the specimens collected from Lake Ossipee, Lake Winnisquam and Great Wass Island yielded numerous spots identified as phenolic compounds by the following criteria: (a) behavior in the developing solvents (Seikel, 1962); (b) reaction to sulfanilic acid; (c) colors under UV light before and after exposure to ammonia (Al-

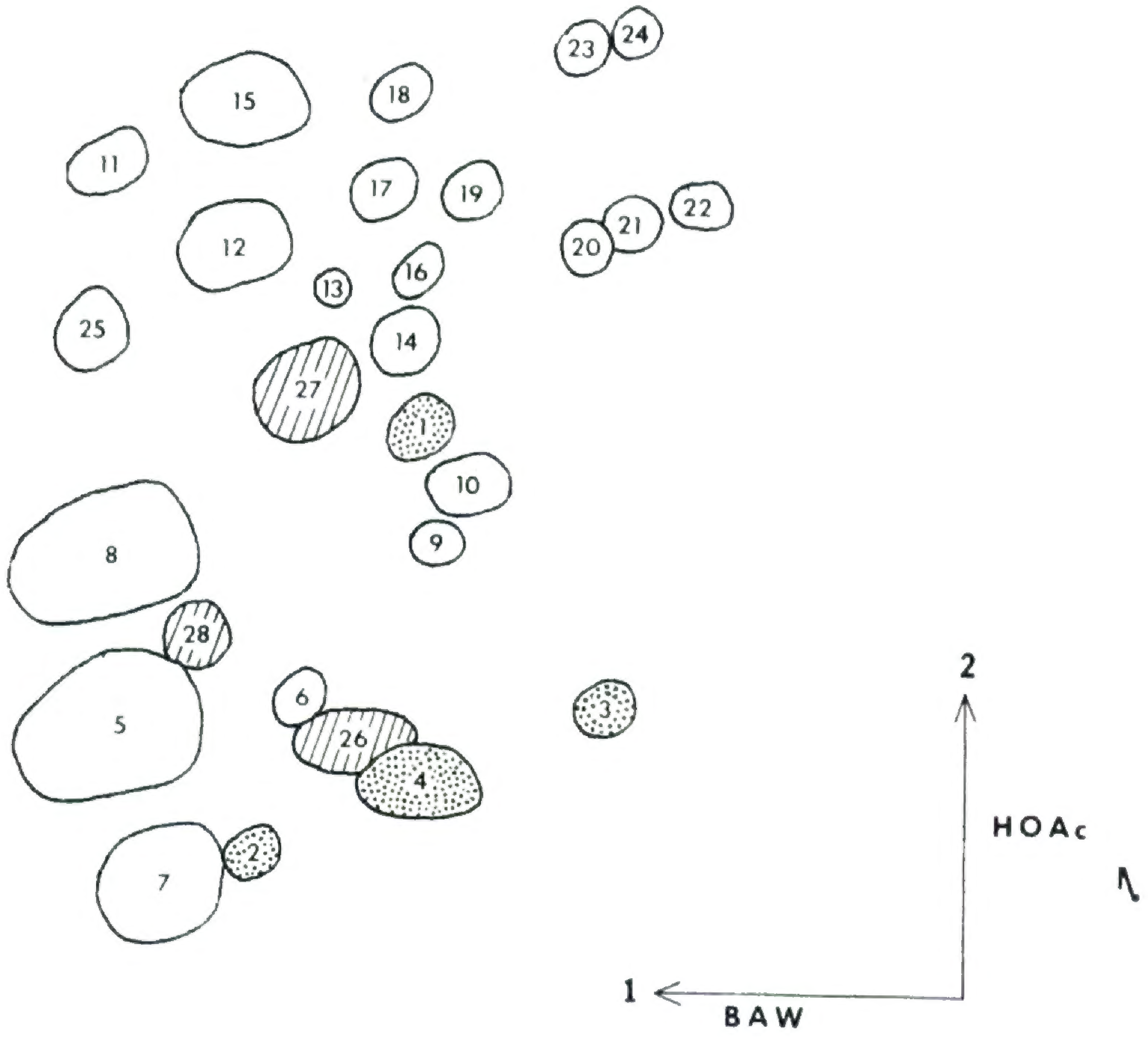


Figure 2. Phenolic profile of *Aster Blakei*, *A. nemoralis*, and *A. acuminatus*. Spots 1, 2, 3, and 4 are specific to *A. nemoralis;* spots 26, 27, and 28 are specific to *A. acuminatus*. The remaining spots are common to all three taxa.

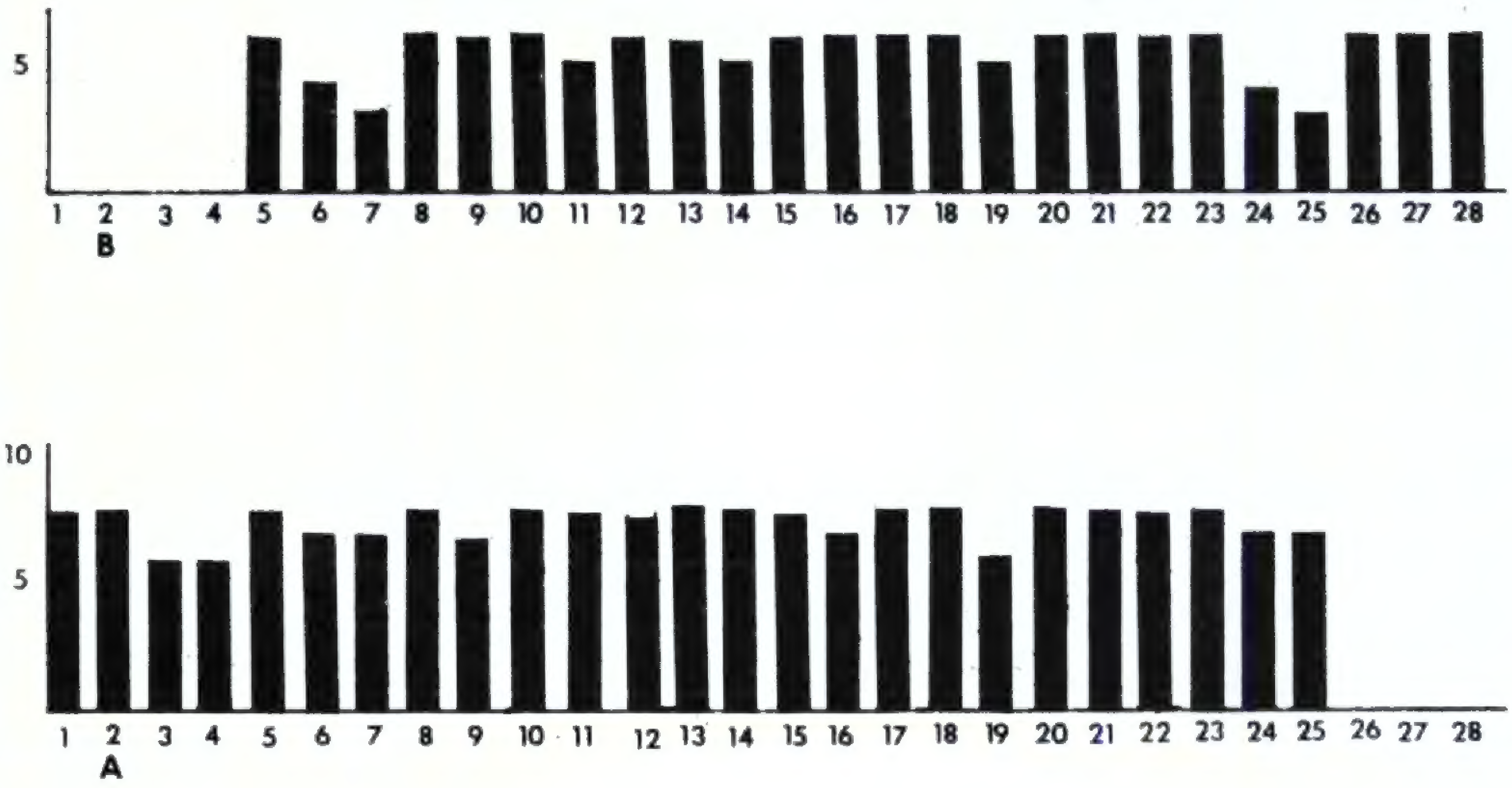


Figure 3. Frequency of occurrence of phenolics characteristic of (a) *Aster nemoralis* and (b) *A. acuminatus* in discrete colonies on Great Wass Island. Numbers refer to spots identified in Figure 2.

ston, 1967); and (d) color reaction to phenolic-specific sprays (Block, *et al.*, 1958). Twenty-eight spots were chosen as diagnostic of these asters because of their high frequency of occurrence or because of their diagnostic value in identifying the parental taxa.

The results of the chemical analysis of the Great Wass Island populations indicate that the parental taxa could be identified on a chemical basis alone. *A. nemoralis,* represented in Figure 1c, contained four compounds which were species-specific. These were compounds numbered 1, 2, 3, and 4 shown in Figure 2. *A. acuminatus,* represented in Figure 1c, contained three compounds which were species-specific. These were compounds numbered 26, 27, and 28 in the phenolic profile in Figure 2. A histogram (Figure 3) of the frequency of occurrence of phenolics in the parental taxa in discrete colonies shows that twenty-one compounds were common to both species. The remaining seven phenolics clearly separate the parental species.

A chemical analysis of the Ponds Point population on Great Wass Island revealed that the parental taxa maintained a similar chemical integrity (Figures 4a, c). *Aster*

Blakei contained a summation of the compounds specific to both parents but did not contain any new species-specific compounds (Figure 4b). The morphological and chemical evidence thus suggests that *A. Blakei* at Ponds Point originated as a hybrid of *A. acuminatus* and *A. nemoralis*. It is clearly a chemical and morphological intermediate of the parental taxa. It is particularly significant that the three taxa could be identified on a chemical basis alone.

The chemical analyses of *A. Blakei* at Lake Winnisquam and Lake Ossipee revealed similar phenolic profiles when compared to *A. Blakei* at Ponds Point. There were differences in the frequency of occurrence of some compounds.

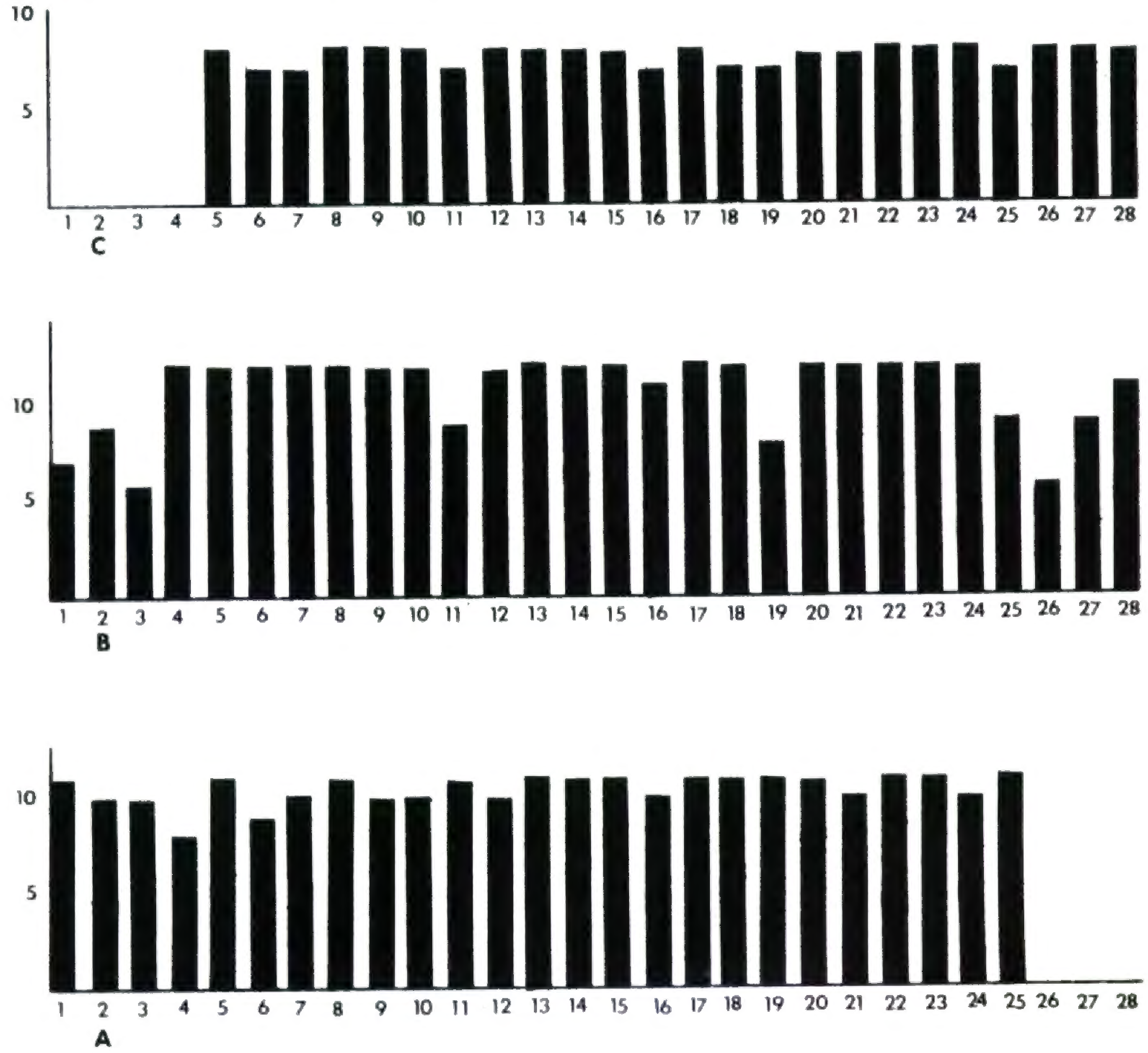


Figure 4. Frequency of occurrence of phenolics characteristic of (a) *Aster nemoralis* (b) *A. Blakei* and (c) *A. acuminatus* at Ponds Point, Great Wass Island. Numbers refer to spots identified in Figure 2.

Table 1. Frequency (in %) of occurrence of compounds diagnostic of *Aster nemoralis* and *A. acuminatus* in relation to morphology in the population at Lake Ossipee, New Hampshire.

Morphological Index	Compound Number				
	2	3	26	27	28
1	50		100		100
2	33	33	100		100
3	67		67		100
4			50		100
8			75	25	75
9			100	100	100
11			100	50	100
12			100	100	100
13			100	100	100
14			100	100	100
15			100	100	100
17			100		

The F_1 hybrids synthesized in the greenhouse demonstrated a high frequency of occurrence of *A. accuminatus* compounds in F_1 hybrids resulting from *A. nemoralis* female parents. The data on the asters collected from the Lakes and from the greenhouse are presented elsewhere (Hill, 1972).

There was evidence for introgression at Lake Ossipee. Table 1 was constructed to show the relationship between chemical and morphological data using a method devised by Levin (1967). High frequencies of *A. acuminatus* compounds numbered 26 and 28 were found in plants which indexed as *A. nemoralis*. Specimens identified as *A. Blakei* contained only *A. acuminatus* phenolics. This suggests that introgression into *A. nemoralis* has been occurring at Lake Ossipee. A pictorialized scatter diagram was constructed according to the methods of Anderson (1949). The diagram was determined from the data on serrate vs. entire

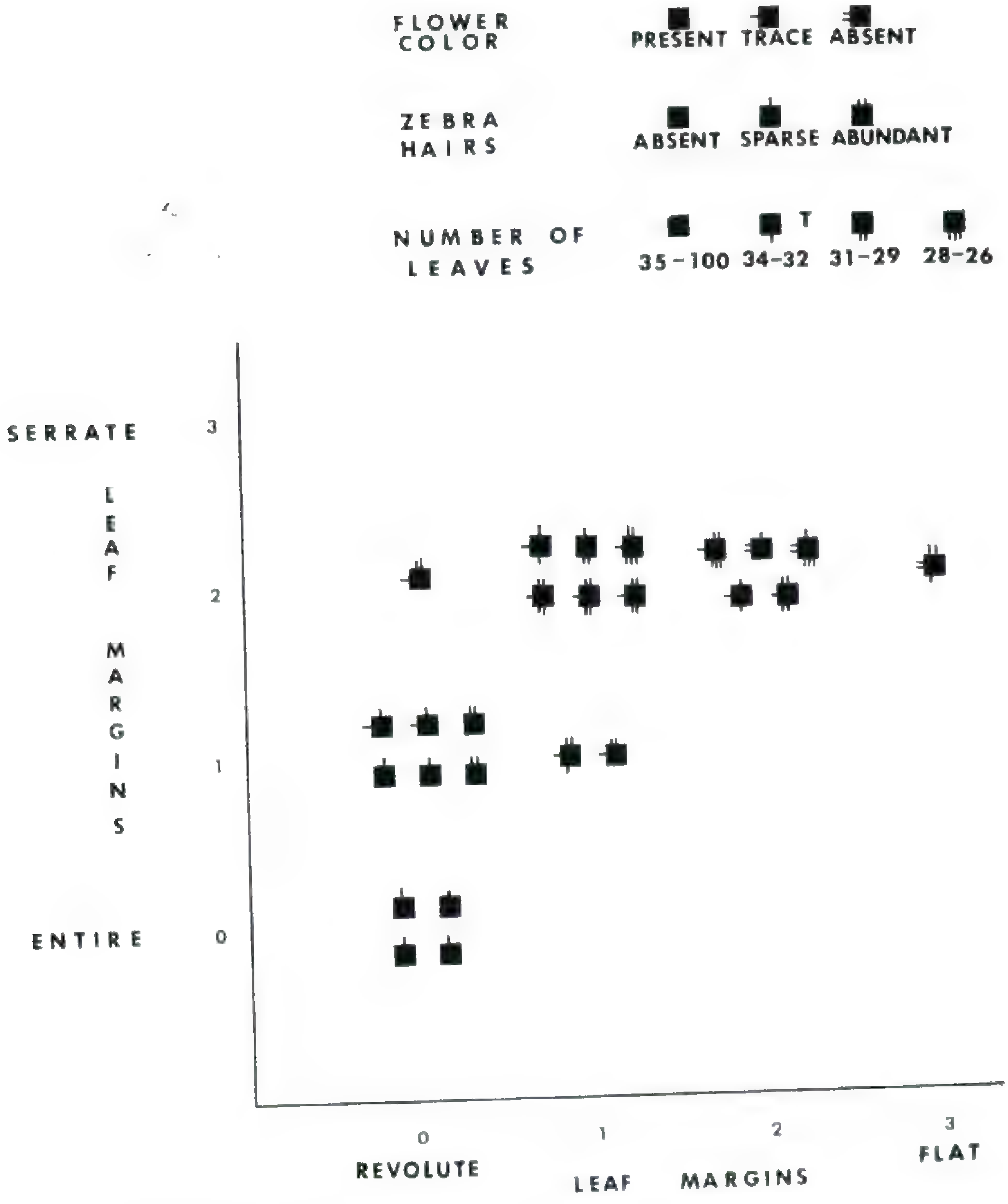


Figure 5. Pictorialized scatter diagram of asters at Lake Ossipee.

leaf margins, revolute vs. flat leaf margins, zebra hairs, flower color and leaf number (Figure 5). Zebra hairs and serrate leaf margins, which are characteristics of *A. acuminatus,* were present in many plants indexed as *A. nemoralis.* This observation provides morphological evidence for the introgression of *A. acuminatus* into *A. nemoralis* at Lake Ossipee. *Aster acuminatus* was not present in this population. The habitat was a disturbed one which was located in an area of land development. There were woody habitats which could have supported *A. acuminatus,* but new roads cut off drainage and many of these areas were too moist and swampy to sustain *A. acuminatus.* It is suggested that the environmental disturbance removed this taxon, leaving *A. Blakei* to cross with *A. nemoralis.* The result is the variable population found there today.

GENETICS

Specimens of *A. acuminatus* and *A. nemoralis* which were collected by Pike were crossed in the fall of 1970 and spring of 1971. The seeds from the fall 1970 crosses were germinated the following spring. These F_1 hybrids were then backcrossed to their parents. Crosses also were made between various F_1 hybrids at that time. The resulting backcross and recombinant progenies were grown during the spring of 1972. Crosses were performed in an insect-free house by rubbing the heads of two plants together when most of the flowers in a head were open and shedding pol-

Table 2. Seed set of the cross *Aster nemoralis* × *A. acuminatus* during two flowering seasons.

Season	Female Parent	Total Flowers Examined	Good Seed	Seed Set (%)
Fall,	*A. nemoralis*	1180	205	17.4
1970	*A. acuminatus*	1191	30	2.1
Spring,	*A. nemoralis*	2426	302	12.5
1971	*A. acuminatus*	2297	26	1.1

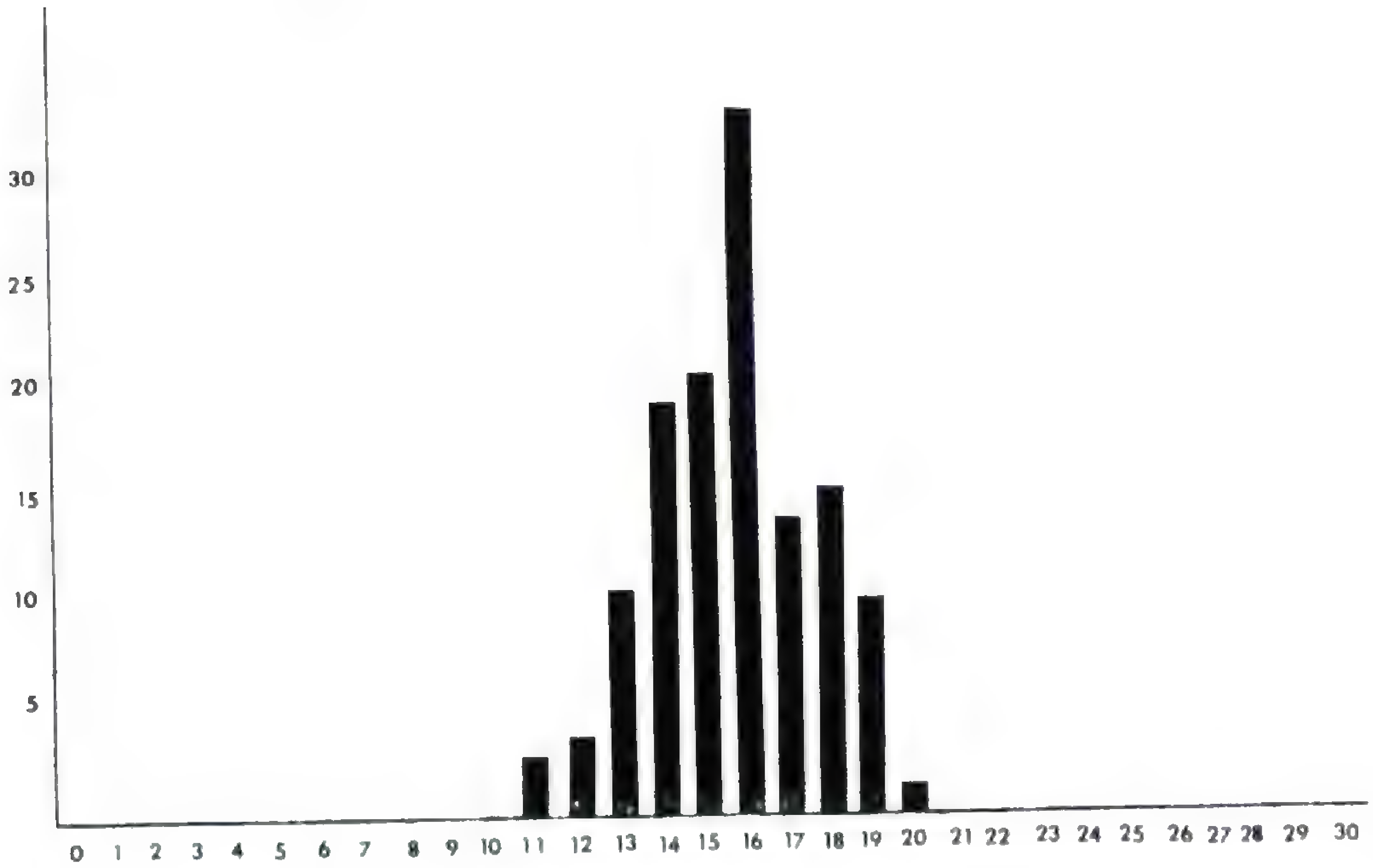


Figure 6. Morphological hybrid index of the F_1 hybrids of the cross *A. nemoralis* × *A. acuminatus.*

len. Seeds from the crosses were stored at room temperature. Before germination they were subjected to a six to seven week treatment at 8°C. in Petri dishes containing moist filter paper. After this cold period, seeds were germinated at 24°C. in a peat-vermiculite mixture covered with ground sphagnum in pots enclosed in plastic bags. Ten days after germination the bags were removed.

Crosses made between *A. nemoralis* and *A. acuminatus* in the fall of 1970 resulted in seed set that was high when *A. nemoralis* was the female parent (Table 2). The same response was obtained in the spring of 1970 using parents from a wider geographic source. The reason for this result probably rests in the presence of a maternal barrier to pollination or fertilization in *A. acuminatus.*

The hybrid index of Pike (1970) was used to score 168 F_1 hybrids. The results are represented in Figure 6. These specimens were morphologically intermediate and fell within the range assigned to *Aster Blakei* by Pike. Representative specimens of *A. Blakei* collected from Lake Ossipee and

Figure 7. *Aster Blakei* from Lake Ossipee (right) and an F_1 hybrid of the cross *A. nemoralis* × *A. acuminatus* (248, left).

Figure 8. *Aster Blakei* from Lake Ossipee (right) and an F_1 hybrid of the cross. *A. nemoralis* × *A. acuminatus* (206, left).

F_1 hybrids from the cross *A. nemoralis* × *A. acuminatus* are compared in Figures 7 and 8. The morphological similarities are quite obvious. Many of the F_1 hybrids also resembled the specimens of *A. Blakei* collected from Lake Winnisquam, Lake Ossipee and Great Wass Island. The F_1 hybrids were morphologically uniform for most characters. Coefficients of variation calculated for the ten characters employed in the hybrid index of Pike (1970) indicated the most variable characters to be internode length, the number of bracts subtending the peduncle and the number of heads (Hill, 1972).

Backcrosses of the parents with the F_1 hybrid resulted in good seed set and seed germination (Table 3). The maternal barriers in *A. acuminatus* that existed for *A. nemoralis* pollen did not exist for pollen from the F_1. The crosses made within the hybrid population also resulted in good seed set and seed germination, although germination was

Table 3. Seed set and seed germination from crosses between the parental taxa and their F_1 hybrid, Spring, 1971.

Female Parent	Flowers Examined	Good Seed	# Germ.	Seed Set (%)	% Germ.
A. acuminatus	1267	345	158	27	46
F_1 Hybrid	1213	476	310	39	65
A. nemoralis	1594	428	217	27	51
F_1 Hybrid	1306	225	111	17	49

Table 4. Seed set and seed germination from the crosses made within the F_1 population, Spring, 1971.

Type of Cross	Flowers Examined	Good Seed	# Germ.	Seed Set (%)	% Germ.
Intrasp.	784	303	124	41	41
Sib	863	357	79	39	22

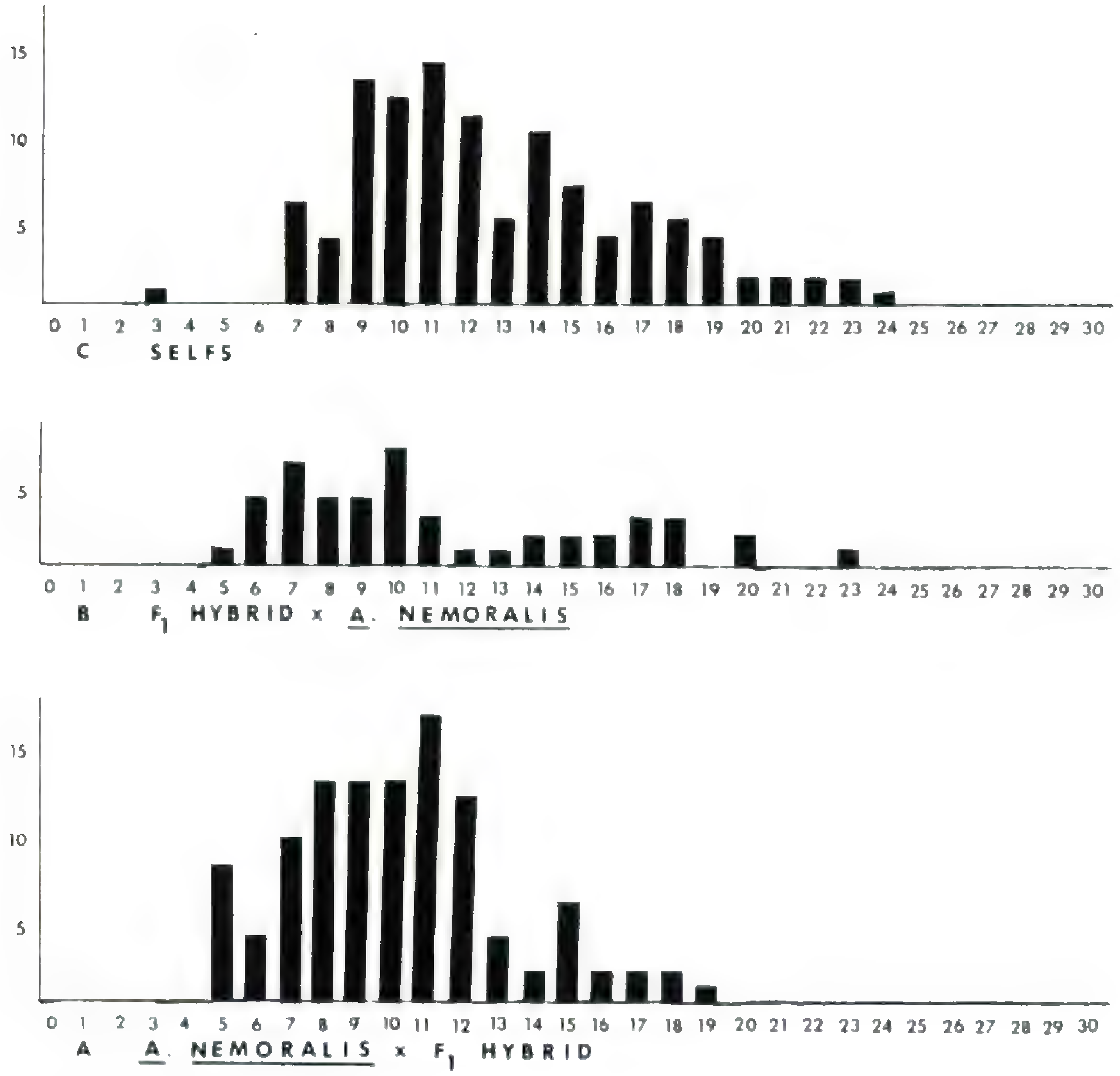


Figure 9. Morphological hybrid index of backcross and recombinant progeny of Asters collected Summer, 1972. The female parent is represented first under each histogram.

lower in progeny from sib-matings as compared with germination of progeny from intraspecific crosses (Table 4).

In the summer of 1972, 462 backcross and 110 recombinant progeny were collected and scored using the hybrid index of Pike (1970). These are represented in Figures 9 and 10. These data indicate that the range of variation assigned to *A. Blakei* by Pike contains backcross and recombinant progeny as well as hybrids. Chromatographs of sixty of these specimens showed chemical evidence for introgression. However, the backcross or recombinant progeny could not be identified on the basis of chemistry alone. Thus,

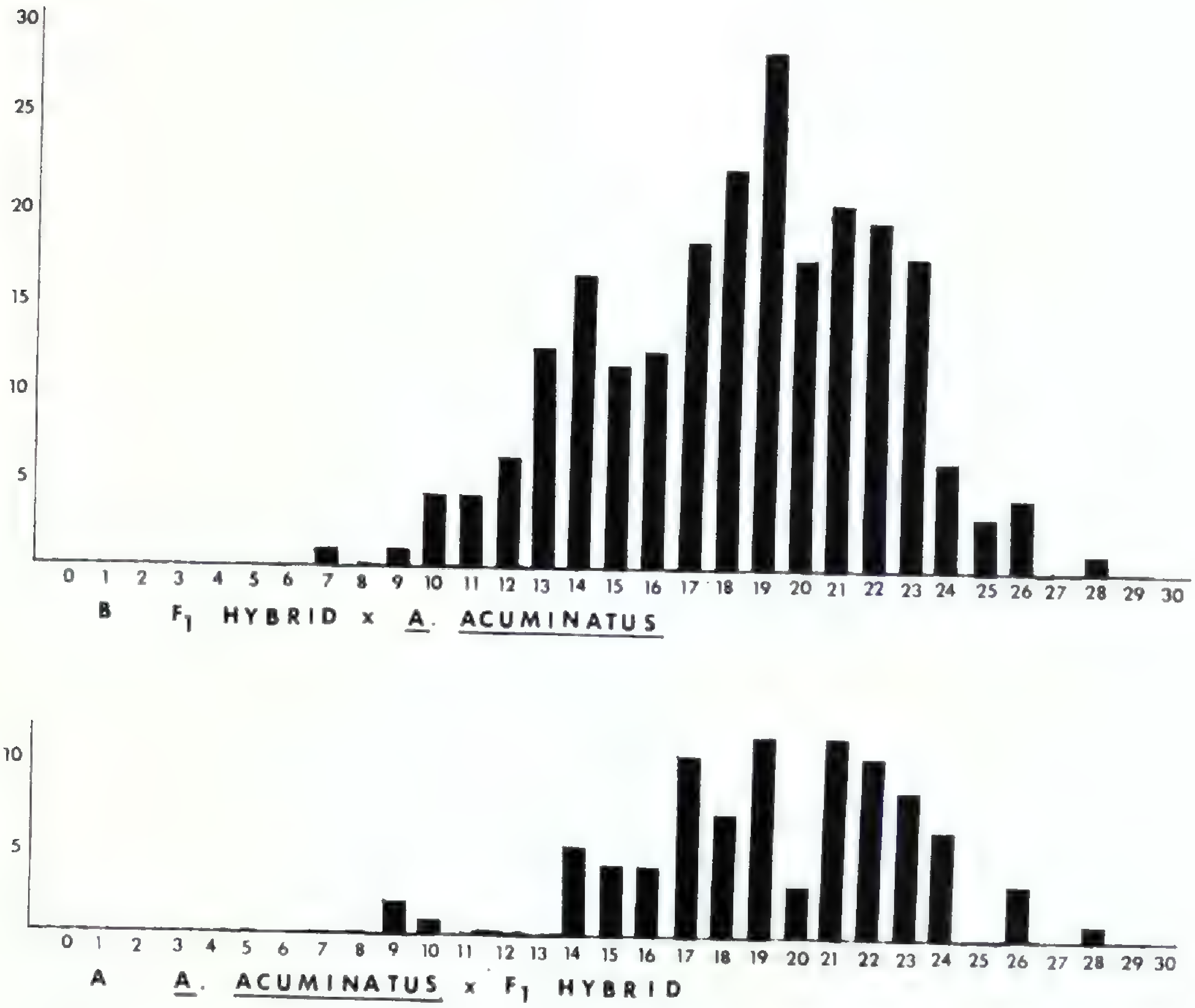


Figure 10. Morphological hybrid index of backcross progeny of Asters collected Summer, 1972. The female parent is represented first under each histogram.

chromatography might not be applicable in determining population structure within this aster complex, although this chemical technique has been successful in this regard in other genera, such as *Coreopsis* (Crawford, 1972) and *Baptisia* (McHale & Alston, 1964). Some of the backcross and recombinant progeny morphologically resembled some of the *A. Blakei* that the senior author has observed in his own collection as well as in Pike's collection and the specimens in the Herbarium at the University of New Hampshire.

The genetic results thus indicate that *A. acuminatus* and *A. nemoralis* can cross and produce a hybrid resembling *A. Blakei.* The hybrid can intercross with its parents and with

Table 5. Mean pollen stainability (%) of the backcross and recombinant progeny of asters collected in the summer of 1972.

Female Parent	plants counted	% stained pollen
A. nemoralis F_1 Hybrid	52	81
A. acuminatus F_1 Hybrid	71	79
A. nemoralis F_1 Hybrid	106	78
A. acuminatus F_1 Hybrid	36	80
F_2 Progeny	78	73

itself. The complex appears capable of forming hybrid swarms which indeed have been observed by Pike (1970) on some of the islands in the Bay of Fundy. He noted that some of these swarms show morphological skewness toward *A. nemoralis*. The data (Table 2) show that crossing between the two parental taxa favors *A. nemoralis* as the female parent. If this crossing occurred in nature, there should be more seeds of the F_1 produced on the *A. nemoralis* parent, and backcrosses would be more numerous in the wetter habitat of *A. nemoralis*. Progenies of the *A. nemoralis* backcrosses would tend to be favored in preference to *A. acuminatus* backcrosses in moist habitats. On the other hand, backcrosses between *A. acuminatus* and the F_1 hybrid were numerous and most were quite vigorous (Table 3). Crosses between *A. nemoralis* and the F_1 hybrid produced progeny which were numerous and vigorous when *A. nemoralis* was the female parent. A morphological skew was also noted toward *A. nemoralis* in the F_2 progeny (Figure 9c). It thus appears that under greenhouse conditions, introgression could go either way, while in nature, the in-

trogression is in the direction of *A. nemoralis*. The determining factor which would promote or inhibit introgression between *A. acuminatus* and *A. nemoralis* would thus be selection by the habitat.

CYTOLOGY

For root tip studies, 0.002 M 8-oxyquinoline was used as a pretreatment for 60-80 minutes at room temperature. The root tips were then stained and squashed in aceto-orcein according to the method of Huziwara (1957). Cover slips were smeared with Mayers albumin and dried over a flame to permit adhering of the preparation to the cover slip. Permanent mounts were made according to the technique of McClintock (1929) with the following modifications; the slide and cover slip were separated in 10% acetic acid using the method of Celeraier (1956); the cover slip was then passed through changes of 1:1, 1:3, and 1:9 acetic alcohol and two changes of 95% ethanol. The slide and cover slip were then recombined in diaphane. For meiotic studies, flower buds were fixed in 1:3 acetic alcohol. Flowers were dissected in a small vial containing 70% alcohol. Each flower suitable for analysis was placed on a slide in a drop of aceto-carmine stain. Permanent slides were made as described above. Chromosomes were observed under oil at 1125×. Photographs were taken with a Kodak camera mounted on a Spencer (A.O.) microscope with the preparation under oil at 1455×.

The chromosome number of these taxa was determined to be $2n = 18$. This was based on counts of mitotic and meiotic chromosomes of asters collected from Lake Ossipee, Gould Pond in Milton, New Hampshire, Great Wass Island, North Lubec, Maine, and Campobello Island in New Brunswick, Canada. A total of forty-three specimens gave good counts. The chromosome numbers of *A. Blakei* and *A. nemoralis* were new and were reported in the literature (Hill and Rogers, 1970). These specimens were not karyotyped. A representative plate of the mitotic chromosomes of *A.*

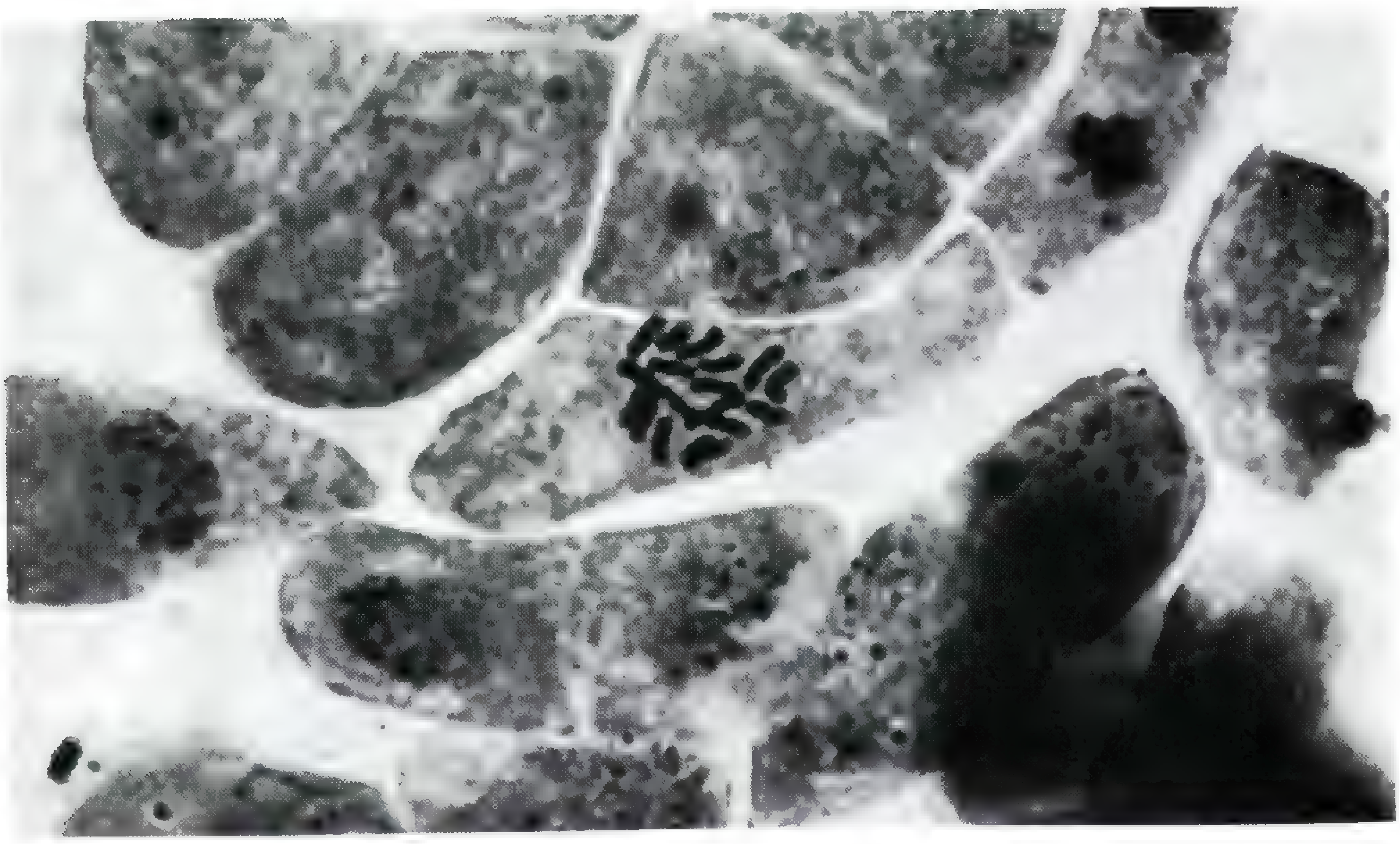
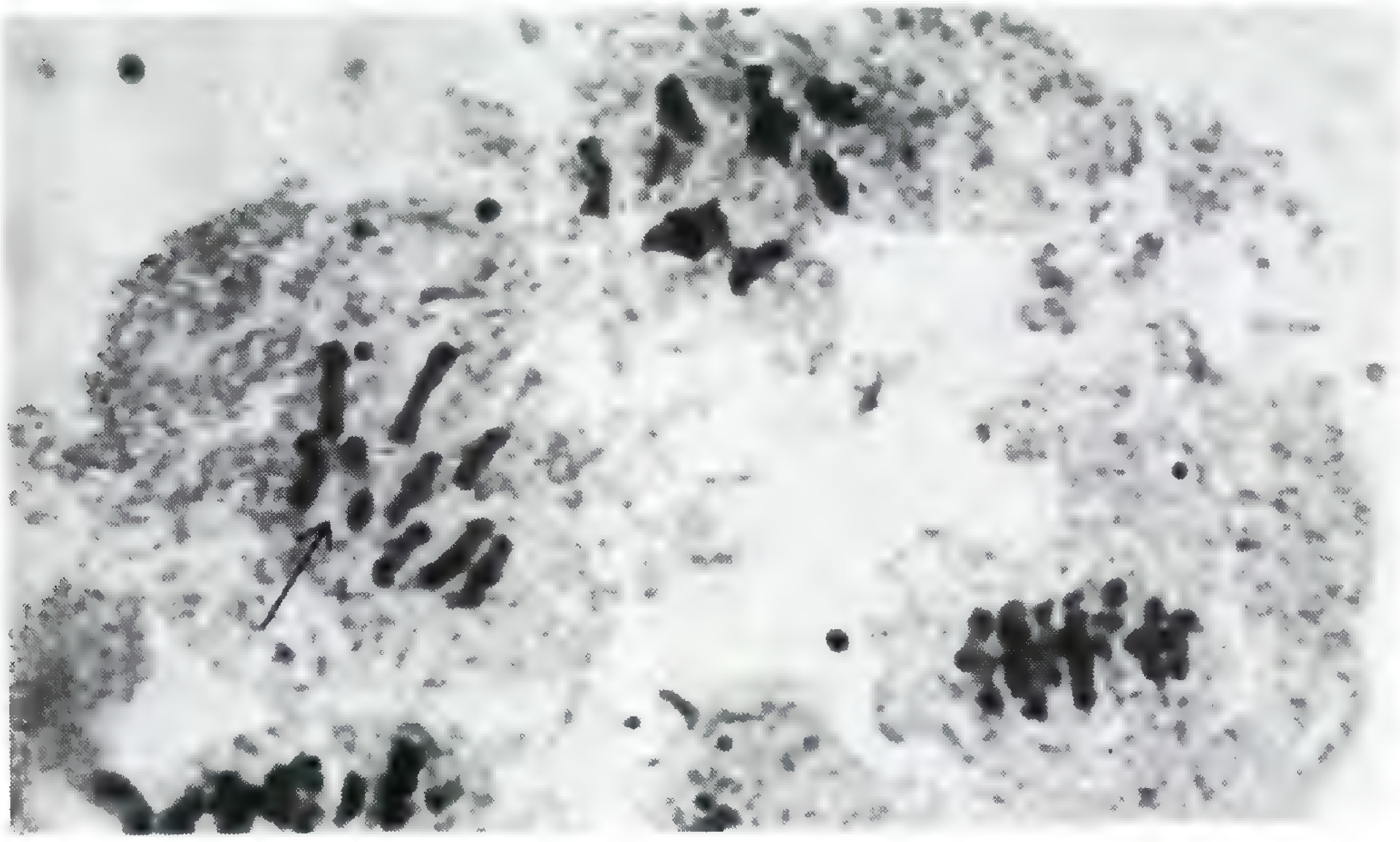


Figure 11. Mitotic chromosomes of *Aster nemoralis*, Metaphase. (above)

Figure 12. Meiotic chromosomes of *Aster Blakei*, Metaphase I. (below) The arrow indicates a loosely associated bivalent.



nemoralis is shown in Figure 11. A plate of the meiotic chromosomes of *A. Blakei* shows nine bivalents, one of them loosely associated (Figure 12). The behavior of the meiotic chromosomes of all three taxa was compared. Both parental taxa formed nine bivalents at meiosis. No irregularities were observed. Pairing in *A. Blakei* was regular although loose associations were occasionally noted. Some bridges and lagging were observed in Anaphase I. Meiotic stages on 239 plates were observed. Of these, 93% showed nine bivalents, and the remaining few demonstrated the irregularities referred to above. Similar observations were noted in the F_1 population.

Pollen from 41 F_1, 265 backcross, and 78 recombinant progeny were stained and scored. The pollen grains were stained with aniline blue in lactophenol, those staining dark blue being scored as fertile. The first 200 grains were scored for stainability under 10× magnification. The results for the backcross and recombinant progeny are listed in Table 5. The mean pollen stainability was lower in these progeny than was the mean stainability in the F_1 hybrid (89-90%) and parents (96-97%). The differences noted in Table 5 were not statistically different. Although it is obvious that a certain degree of hybrid breakdown has occurred, it appears that the F_1, backcross and recombinant progeny synthesized in the greenhouse are fertile.

CONCLUSIONS

The chemical evidence indicated that specimens identified as *A. Blakei* were clearly intermediates of *A. acuminatus* and *A. nemoralis*. Identification of *A. nemoralis, A. acuminatus* and *A. Blakei* could be done on the basis of phenolic examination alone. This is also true of the F_1 hybrids of the cross *A. nemoralis* × *A. acuminatus*. Backcross or recombinant progeny could be identified morphologically, but they could not be identified on the basis of chemistry alone.

The genetic evidence indicated that the hybrid of *A. acuminatus* and *A. nemoralis* was attainable and was in-

distinguishable from *A. Blakei.* The parental taxa can intercross with the F_1 hybrid and the F_1 hybrid can produce F_2 progeny. The production of a hybrid swarm in the greenhouse thus suggests the production of hybrid swarms in nature. The backcross and recombinant progeny were indistinguishable from some specimens of *A. Blakei.*

The cytological evidence demonstrated that the chromosome number for *A. Blakei, A. acuminatus,* and *A. nemoralis* was $2n = 18$. *A. Blakei* and the F_1 hybrid demonstrated regular meiosis most of the time. Pollen stainability with aniline blue in lactophenol was very high in both parental taxa, lower in the F_1 hybrid and even lower in the backcross and recombinant progeny. The evidence suggested that *A. Blakei* was a fertile species hybrid.

The data thus lead to a confirmation of Pike's (1970) hypothesis that A. *Blakei* is a hybrid of *A. acuminatus* and *A. nemoralis.* It is always difficult to assess the exact size of a species population in terms of the number, location, and size of individual sub- or local populations over a species range. Our sample sizes reflect only a small area that covers the range of *A. Blakei.* Keeping this in mind, we wish to suggest that *A. acuminatus* and *A. nemoralis* are semi- or incipient species. They remain isolated by geography but cross within their overlapping ranges when the opportunity is presented. The major isolating barrier between the species would be the absence of hybrid or recombinational habitats when interspecific crossing occurs.

ACKNOWLEDGMENTS

Thanks are extended to Dr. Radcliffe B. Pike for his efforts in collecting the parental asters used in the genetic portion of this study, for his help in cultivating asters from seed and for his aid in locating the asters at Ponds Point, Great Wass Island. The hospitality of the summer residents near Ponds Point is also greatly appreciated. Thanks are also due to Dr. Albion R. Hodgdon for his help in locating the populations at Lake Ossipee and Lake Winnisquam. We

also thank Dr. L. C. Peirce, Professor and Chairman of Plant Science and Dr. Douglas Routley, Professor of Plant Science, both of the University of New Hampshire, for the critical reading of this manuscript. Voucher specimens for this work have been placed in the Herbarium of the University of New Hampshire.

LITERATURE CITED

ABRAHAMSON, WARREN G., & OTTO T. SOLBRIG. 1970. Soil preferences and variation in flavonoid pigments in species of *Aster*. Rhodora **72**: 251-263.

ALSTON, R. E. 1965. Flavonoid chemistry of *Baptisia*: A current reevaluation of chemical methods in the analysis of interspecific hybridization. Taxon **14**: 268-274.

__________. 1967. Biochemical systematics. In: T. Dobshansky, M. Hecht and W. C. Steere, eds., Evolutionary biology, Vol. 1. Appleton-Century Crosts, New York. pp. 197-305.

__________, & B. L. Turner. 1962. New techniques in analysis of complex natural hybridization. Proc. Natl. Acad. Sci., U.S.A. **48**: 130-137.

ANDERSON, EDGAR. 1929. Variation in *Aster anomalous*. Annals Missouri Bot. Gard. **15**: 129-140.

__________. 1949. Introgressive hybridization. John Wiley and Sons, Inc., New York. 109 pp.

AVERS, CHARLOTTE, J. 1953a. Biosystematic studies in *Aster*. I. Crossing relationships in the Heterophylli. Amer. Jour. Bot. **40**: 669-675.

__________. 1953b. Biosystematic studies in *Aster*. II. Isolating mechanisms and some phylogenetic considerations. Evolution **7**: 317-327.

BLOCK, R. J., E. L. DURRUM, & G. ZWEIG. 1958. A manual of paper chromatography and paper electrophoresis. Second edition. Academic Press, Inc., New York. 710 pp.

CARTER, LYNN C., & B. G. BREHM. 1969. Chemical and morphological analysis of introgressive hybridization between *Iris tenax* and *Iris chrysophylla*. Brittonia **21**: 44-54.

CELARIER, ROBERT P. 1956. Tertiary butyl alcohol dehydration of chromosome smears. Stain Technol. **31**(4): 155-157.

CRANG, RICHARD E., & H. L. DEAN. 1971. An intergeneric hybrid in the Sileneae (Caryophyllaceae) Bull. Torrey Bot. Club **98**: 214-217.

CRAWFORD, DANIEL J. 1972. The morphology and flavonoid chemistry of synthetic infraspecific hybrids in *Coreopsis mutica* (Compositae). Taxon **21**: 27-38.

FAHSELT, DIANE, & MARION OWNBEY. 1968. Chromatographic comparison of *Dicentra* species and hybrids. Amer. Jour. Bot. **55**: 334-345.

FERNALD, M. L. 1950. Grays Manual of Botany. Eighth edition. American Book Company, New York. 1632 pp.

HARBORNE, J. B. 1968. The use of secondary chemical characters in the systematics of higher plants. In: J. G. Hawkes, ed., Chemotaxonomy and serotaxonomy. Academic Press, New York. pp. 173-191.

HILL, L. MICHAEL. 1972. Chemical, cytological and genetic considerations of the possible hybrid origin of *Aster Blakei* (Porter) House. Doctoral Dissertation, The University of New Hampshire, Durham, New Hampshire. 84 pp.

————————, & O. M. ROGERS. 1970. Chromosome numbers of *Aster Blakei* and *A. nemoralis*. Rhodora **72**: 437-438.

HUZIWARA, Y. 1957. Karyotype analysis in some genera of Compositae. II. The karyotype of Japanese *Aster* species. Cytologia **22**: 96-112.

JAWORSKA, H., & N. NYBOM. 1967. A thin-layer chromatographic study of *Saxafraga caesia*, *S. aizoides*, and their putative hybrid. Hereditas **57**: 159-177.

LEVIN, D. 1967. An analysis of hybridization in *Liatris*. Brittonia **19**: 248-260.

MCCLINTOCK, B. 1929. A method for making aceto-carmin smears permanent. Stain Technol. **4**: 53-56.

MCHALE, JANICE, & R. E. ALSTON. 1964. Utilization of chemical patterns in the analysis of hybridization between *Baptisia leucantha* and *B. sphaerocarpa*. Evolution **18**: 304-311.

OLDEN, E. J., & N. NYBOM. 1968. On the origin of *Prunus cerasus* L. Hereditas **59**: 327-345.

PIKE, R. B. 1970. Evidence for the hybrid status of *Aster Blakei* (Porter) House. Rhodora **72**: 401-436.

ROSENDAHL, C. O., & ARTHUR CRONQUIST. 1949. The Asters of Minnesota: a floristic study. Amer. Mid. Nat. **42**: 502-512.

SEIKEL, MARGARET K. 1962. Chromatographic methods of separation, isolation and identification of flavonoid compounds. In: T. A. Geissman, ed., The chemistry of flavonoid compounds. The MacMillan Company, New York. pp. 34069.

SHINNERS, L. H. 1941. The genus *Aster* in Wisconsin. Amer. Midl. Nat. **26**: 398-420.

SMITH, DALE M., & D. A. LEVIN. 1963. A chromatographic study of reticulate evolution in the appalachian *Asplenium* complex. Amer. Amer. Jour. Bot. **50**: 952-958.

SMITH, I., ed. 1960. Chromatographic and electrophoretic techniques. Volume I. Interscience Publishers, New York. 617 pp.

TURNER, B. L., & R. E. ALSTON. 1959. Segregation and recombination of chemical constituents in a hybrid swarm of *Baptisia laevicaulis* × *B. viridis* and their taxonomic implications. Amer. Jour. Bot. **46**: 678-686.

————————, & T. J. MABRY. 1964. Partition chromatography as applied to taxonomic problems in the Asteraceae. Taxon **13**: 11-14.

UTTAL, L. J. 1962. Synthesis of *Aster Herveyi*. Rhodora **64**: 113-117.

WALKER, SALLY A. 1969. Cytological and chromatographic evidence for interspecific hybridization in *Petalostemon*. Annals Missouri Bot. Gard. **56**: 261-267.

WETMORE, RALPH, & ALBERT L. DELISLE. 1939. Studies in the genetics and cytology of two species in the genus *Aster* and their polymorphy in nature. Amer. Jour. Bot. **26**: 1-12.

DEPARTMENT OF BIOLOGY
BRIDGEWATER COLLEGE
BRIDGEWATER, VIRGINIA 22812

DEPARTMENT OF PLANT SCIENCE
NESMITH HALL
THE UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824

CHROMOSOME NUMBERS IN ASTER

PAUL VAN FAASEN AND FERN FRANK STERK

Chromosome numbers are of ever-increasing importance to modern plant systematists. Although there have been numerous contributions made in this area over the past 25 years, the chromosome numbers of most plants remain unknown. Even in some large genera which contain abundant and widespread species, many chromosome numbers are known from a single count, or from a few counts taken from a restricted portion of the range of a species. Considering the value of the knowledge of chromosome numbers to evolutionary and taxonomic discussion (see Davis & Heywood 1963), it seems appropriate to expand this aspect of our knowledge whenever possible.

As a necessary early step in a study of the variability and hybridizing capability in the *Aster lateriflorus-simplex-pilosus* complex, collections of these and other species of *Aster* were made, primarily in the northeastern United States, in 1970. Buds were collected in Carnoy's 6:3:1 and maintained at ambient temperatures. Chromosome numbers, using standard squash techniques, were determined in pollen mother cells undergoing meiosis, and, in a few cases, in root tip cells which were undergoing mitotic divisions. Chromosome counts from 32 populations of 17 different species, along with locality data, are found in Table 1. These data include the first count reported for *A. gracilis* ($n = 9$); a count ($n = 24$) for *A. concinnus*, different from that previously reported for the species ($2n = 46$, Huziwara 1958); and a diploid count ($n = 9$) for *A. undulatus*, a species previously reported only as a tetraploid ($n = 18$, Avers 1953a, b). In addition, previous chromosome counts for those species included in this study are presented. Voucher specimens are deposited in the herbarium at Hope College.

Table 1.

Species	Chromosome Number	Locality data
Aster acuminatus Michx.	*n* = 9	**NEW HAMPSHIRE:** CARROLL CO. North Shore of Dan Hole Pond. *Van Faasen 2712.*
	n = 9	**MAINE:** OXFORD CO. 2.6 miles North of Bethel. *Van Faasen 2725.*
	n = 9	**VERMONT:** ESSEX CO. 9.1 miles west of North Stratford. *Van Faasen 2730.*
Aster ciliolatus Lindl.	*n* = 36	**MICHIGAN:** EMMET CO. 1 mile South of Mackinaw City. *Van Faasen 2787.*
Aster concinnus Willd.	*n* = 24	**PENNSYLVANIA:** MONROE CO. 0.5 mile North of Marshalls Creek. *Van Faasen 2776.*
Aster cordifolius L.	*n* = 18	**MAINE:** OXFORD CO. 2.6 miles North of Bethel. *Van Faasen 2724.*
	n = 18	**NEW HAMPSHIRE:** COOS CO. 8.9 miles South of North Stratford. *Van Faasen 2728.*
Aster gracilis Nutt.	*n* = 9	**NEW JERSEY:** BURLINGTON CO. 1 mile North of Green Bank. *Van Faasen 2753.*
Aster junciformis Rydb.	*n* = 16	**NEW HAMPSHIRE:** COOS CO. 0.5 mile North of Gorham. *Van Faasen 2727.*
Aster lateriflorus (L.) Britt.	*n* = 16	**PENNSYLVANIA:** MONROE CO. Delaware Water Gap. *Van Faasen 2763.*

Species	Chromosome Number	Locality data
	$n = 16$	**NEW JERSEY:** SUSSEX CO. 7 miles South of Montague. *Van Faasen 2780.*
Aster lowrieanus Porter	$n = 18$	**PENNSYLVANIA:** MONROE CO. 5 miles North of Marshalls Creek. *Van Faasen 2775.*
Aster macrophyllus L.	$n = 36$	**VERMONT:** CALEDONIA CO. 2.8 miles North of Groton. *Van Faasen 2746.*
	$n = 36$	**NEW HAMPSHIRE:** GRAFTON CO. 1 mile West of Warren. *Van Faasen 2749.*
Aster patens Ait.	$n = 10$	**NEW JERSEY:** BURLINGTON CO. Chatsworth. *Van Faasen 2758.*
Aster pilosus Willd.	$2n = 48$	**MICHIGAN:** OTTAWA CO. 3 miles South of Zeeland. *Van Faasen 2674.*
Aster puniceus L.	$n = 8$	**MAINE:** OXFORD CO. 0.5 mile East of Bryant Pond. *Van Faasen 2719.*
	$n = 8$	**VERMONT:** CALEDONIA CO. 2.8 miles North of Groton. *Van Faasen 2745.*
Aster sagittifolius Wedem.	$n = 18$	**VERMONT:** CALEDONIA CO. 2.8 miles North of Groton. *Van Faasen 2747.*
Aster simplex Willd.	$2n = 32$	**MICHIGAN:** ALLEGAN CO. New Richmond. *Van Faasen 2685.*
	$n = 16$	**MAINE:** CUMBERLAND CO. 0.5 mile North of West Baldwin. *Van Faasen 2717.*

Species	Chromosome Number	Locality data
	$n = 16$	**MAINE:** OXFORD CO. 2.6 miles North of Bethel. *Van Faasen 2723.*
	$n = 16$	**NEW JERSEY:** SUSSEX CO. 0.5 mile North of Montague. *Van Faasen 2778.*
	$n = 16$	**MICHIGAN:** ALGER CO. 0.5 mile South of Grand Marais. *Van Faasen 2785.*
	$n = 32$	**MAINE:** YORK CO. 1 mile west of Porter. *Van Faasen 2713.*
	$n = 32$	**VERMONT:** CALEDONIA CO. 2.8 miles North of Groton. *Van Faasen 2748.*
Aster spectabilis Ait.	$n = 36$	**NEW JERSEY:** BURLINGTON CO. 3 miles South of Chatsworth. *Van Faasen 2754.*
Aster umbellatus Mill.	n = 9	**MAINE:** YORK CO. 1 mile West of Porter, *Van Faasen 2714.*
	$n = 9$	**MAINE:** OXFORD CO. 0.5 mile East of Bryant Pond. *Van Faasen 2720.*
	$n = 9$	**VERMONT:** ESSEX CO. 9.1 miles West of North Stratford. *Van Faasen 2736.*
Aster undulatus L.	$n = 9$	**MAINE:** CUMBERLAND CO. 0.5 miles North of West Baldwin. *Van Faasen 2718.*
	$n = 18$	**PENNSYLVANIA:** MONROE CO. 0.5 mile North of Marshalls Creek. *Van Faasen 2777.*

DISCUSSION

Aster acuminatus Michx. Counts of $n = 9$ from three different populations confirm those for this species as previously reported by Nelson (1966), Smith (1966), and Hill & Rogers (1970).

Aster ciliolatus Lindl. This count ($n = 36$) is the same as reported for this species by Avers (1953a, b), Van Faasen (1963), and Löve & Löve (1964).

Aster concinnus Willd. The chromosome count ($n = 24$) for this species, as determined in this study, places *A. concinnus* in that very diverse group of asters based on $x = 8$. Huziwara (1958) reported $2n = 46$, an unusual count for *Aster*, for this species. He suggested that it was a "hypo hexaploid", presumably a product of aneuploid loss from $2n = 48$.

Aster cordifolius L. The only previous tetraploid ($n = 18$) counts for this species are by Van Faasen (1963) who also reported diploid plants. Avers (1953a, b, and 1954a, and 1957) reports only diploids for this species.

Aster gracilis Nutt. This count, $n = 9$, is apparently the first count reported for this species and places the species in that large group of *Aster* species based on $x = 9$.

Aster junciformis Rydb. A count of $n = 16$ confirms the previous count for this species made by Van Faasen (1963) but differs from the count $n = 27$ reported by Taylor (1967).

Aster lateriflorus (L) Britt. Two tetraploid populations ($n = 16$) confirm that count by Van Faasen (1963) who also reported diploid and hexaploid populations of *A. lateriflorus*. Mulligan (1967) also reports $n = 16$ in this species.

Aster lowrieanus Porter. A count of $n = 18$ confirms that count for this species made by Avers (1953a). Van Faasen's (1963) count $n = 9$ for a specimen tentatively identified as *A. lowrieanus* must be attributed to a variant form of *A. cordifolius*.

Aster macrophyllus L. Counts of $n = 36$ confirm those

reported by Huziwara (1941), Van Faasen (1963), Löve & Löve (1964), and Mulligan (1967).

Aster patens Ait. Tetraploid counts of $n = 10$ were also reported by Huziwara (1941) and Avers (1954b). Jones (1968), however, reports a diploid count of $n = 5$.

Aster pilosus Willd. Avers (1954b), Huziwara (1958) and Van Faasen (1963) also report hexaploid counts ($2n = 48$) for this species. Bostick (1965) reports the unusual count $n = 12$ for *A. pilosus*.

Aster puniceus L. The count of $n = 8$ agrees with counts previously reported by Huziwara (1958), Van Faasen (1963)and Löve & Löve (1964, 1966). Chouksanova et al. report $2n = 36$ for this species (1968).

Aster sagittifolius Wedem. Tetraploid ($n = 18$) counts were also reported by Avers (1953a, b) and Van Faasen (1963), both of whom also reported diploid counts for this species.

Aster simplex Willd. Counts of $n = 16$ and $n = 32$ confirm previous counts by Avers (1954b), Huziwara (1958), and Van Faasen (1963).

Aster spectabilis Ait. Solbrig et. al (1964) also reported $n = 36$ for this species.

Aster umbellatus Mill. Diploid ($n = 9$) counts for *A. umbellatus* were also reported by Huziwara (1962), Löve & Löve (1964, 1966), Jones (1966) and Van Faasen (1963).

Aster undulatus L. Avers (1953a, b) also reported $n = 18$ for this species but this is the first report of diploid plants ($n = 9$) for this species.

ACKNOWLEDGEMENTS

Fieldwork was suported, in part, by a Sigma Xi grant-in-aid to the senior author and laboratory work by the junior author was supported, in part, by a National Science Foundation Undergraduate Research Participation Grant.

The authors are grateful for this support of their studies on the genus *Aster*.

LITERATURE CITED

AVERS, C. J. 1953a. Biosystematic studies in *Asters* I. Crossing relationships in the *Heterophylli*. Amer. Jour. Bot. **40**: 669-675.

————. 1953b. Biosystematic studies in *Aster*. II. Isolating mechanisms and some phylogenetic considerations. Evolution **7**: 317-327.

————. 1954a. Chromosome behavior in fertile triploid *Aster* hybrids. Genetics **39**: 117-126.

————. 1954b. Documented chromosome numbers of plants. Madroño **12**: 210.

————. 1957. Fertile hybrids derived from a wide species cross in *Aster*. Evolution **11**: 482-486.

BOSTICK, P. E. 1965. Documented chromosome numbers of plants 65: 2. Sida **2**: 165-168.

CHOUKSANOVA, N. A., *et al.* 1968. Data on karyology of the family Compositae Giseke. Citologija **10**: 198-206.

DAVIS, P. H., & V. H. HEYWOOD. 1963. Principles of angiosperm taxonomy. Van Nostrand, Princeton, N.J. 556 pp.

HILL, L. M., & O. M. ROGERS. 1970. Chromosome numbers of *Aster blakei* and *A. nemoralis*. Rhodora **72**: 437-438.

HUZIWARA, Y. 1941. On the chromosomes of some species of *Aster* from foreign countries. Bot. Zool. **9**: 75-76.

————. 1958. Karyotype analysis in some genera of Compositae. V. The chromosomes of American *Aster* species. Jap. Jour. Genet. **33**: 129-137.

————. 1962. Karyotype analysis in some genera of Compositae IX. Chromosomes of European species of *Aster*. Bot. Mag. Tokyo **75**: 143-149.

JONES, S. B., JR. 1966. Compositae chromosome numbers. Bull. Torrey Bot. Club **93**: 278-279.

————. 1968. Chromosome numbers in southeastern United States Compositae. Bull. Torrey Bot. Club **95**: 393-395.

LÖVE, A. & D. LÖVE. 1964. *In* IOPB Chromosome number reports I. Taxon **13**: 100-110.

————, & ————. 1966. Cytotaxonomy of the alpine vascular plants of Mount Washington. Univ. Colorado Studies Ser. Biol. **24**: 1-74.

MULLIGAN, G. A. 1967. *In* IOPB chromosome number reports XI. Taxon **16**: 215-222.

NELSON, A. D. 1966. *In* IOPB chromosome number reports VII. Taxon **15**: 155-163.

SMITH, E. B. 1966. *In* IOPB chromosome number reports VII. Taxon **15**: 155-163.

SOLBRIG, O. T., *et al.* 1964. Chromosome numbers in Compositae V. Astereae II. Amer. Jour. Bot. **51**: 513-519.

TAYLOR, R. L. 1967. *In* IOPB chromosome number reports XIII. Taxon **16**: 445-461.

VAN FAASEN, P. 1963. Cytotaxonomic studies in Michigan asters. Mich. Bot. **2**: 17-27.

BIOLOGY DEPARTMENT
HOPE COLLEGE
HOLLAND, MICHIGAN 49423

THE NORTHERN LIMITS OF THE DISTRIBUTIONS OF HICKORIES IN NEW ENGLAND

Wayne E. Manning

Five species of hickories are native to New England, mockernut hickory, *Carya tomentosa* (Poir.) Nutt., bitternut hickory, *C. cordiformis* (Wang.) K. Koch, shagbark hickory, *C. ovata* (Mill.) K. Koch, pignut hickory, *C. glabra* (Mill.) Sweet, and sweet pignut or red hickory, *C. ovalis* (Wang.) Sarg. The last species, at one time combined by Little (1953) with *C. glabra*, has recently been designated by him (Little, 1969) as *C. glabra* var. *odorata* (Marsh.) Little.

The exact distribution in New England of these species is still not fully known. Except for some records in southern Quebec, the northern limits in New England represent the northeast limits of the species. The ranges given in various books and on the distribution maps are largely inaccurate and contradictory. This is due partly to lack of collecting, partly to misidentification and partly to guesswork where specimens are unknown. The greatest error is in the distribution of the mockernut. Some of the descriptions of the ranges are much condensed and indefinite, many incorrect; also maps on a smaller scale are usually highly generalized. The best maps in accuracy and detail not only for New England but also Canada and the rest of the United States are those of Little (1965, 1971). The greatest detail in range in New England is given by Blakeslee and Jarvis (1911) and by Seymour (1969, 1970); these are not entirely correct or complete. Seymour gives the distribution by counties and towns and one must know the location of these to fully understand the distribution.

This paper is an attempt to correct as far as possible the ranges of the hickories in New England, and thus show the northeast limits of the species. This will lay a foundation for future workers to make better maps and descriptions of ranges. Also clear are locations where future field

work will be of value. For this study I have checked the identification of the hickories in the major herbaria of northern and central New England: University of Maine (MN, MAINE), U. of New Hampshire (NH, NHA), U. of Vermont (V, VT), U. of Massachusetts (MS, MASS), Dartmouth College (H, HNH), Arnold Arboretum (A, A), Gray Herbarium (G, GH), New England Botanical Club (N, NEBC), Clark University (C, CUW), and Smith College, (S, SCHN). For each herbarium the first symbol is that which I will use in this paper, the second is the official one in *Index Herbariorum* (Lanjouw and Stafleu, 1964). Furthermore, I have recently collected rather extensively in Vermont, western New Hampshire, and northern Massachusetts; the field work has added over 50 towns to the lists of towns given by Seymour (1969). My specimens are deposited in various New England herbaria. The results of my study are given below in the lists of counties and towns under each species and on the maps. In the lists are given the symbols for the names of the herbaria where specimens are located. The symbol "WM" refers to my herbarium at Bucknell University, and "Z" refers to the observation by Dr. Robert Zimmerman, who did not collect specimens. For each species one map gives the detailed presently known distribution indicated for each town in Vermont, New Hampshire, Maine and Massachusetts where a specimen has been collected. A second map shows Little's distribution with my corrections in the New England area; his distribution in eastern New York is included, in order to show where one might look for the species in adjacent areas in New England where no records are now known. With extremely few exceptions I have seen herbarium specimens for each record I have given. The maps and lists of towns are still incomplete as collections are incomplete; there will undoubtedly be additions of towns within the ranges and some extensions of ranges with future collecting. Some of the towns I have given may represent planted trees as it is difficult to be sure of the situation from meager notes on herbarium specimens; even in the

field there are often uncertainties. In Maine, Hyland and Steinmetz (1944) have definitely distinguished native from planted trees, removing pignut and bitternut from the list of native trees of Maine, and indicating in which counties the only native species, *Carya ovata*, is indigenous, and in which it is planted.

It is well known that because of overlapping features and the tremendous variation hickories are very difficult to identify. Thus every species in New England may have hairy leaflets, hairy rachises, 7 leaflets. I have discussed the features used in identification, given suggestions for collecting specimens, and presented a detailed key to species using vegetative as well as reproductive features (Manning, 1950). A less detailed and somewhat modified key to New England species is given below. A full distinction between *C. glabra* and *C. ovalis* is given in the key, despite the fact that the distribution is discussed later under *C. glabra-ovalis* complex.

Under each species are given comments on distribution records. Changes from the maps of Little (1965, 1971) are indicated here as well as on the maps. Also given is a suggested description of the range in New England.

Key to New England species of *Carya*

1. Buds completely yellow, scurfy, flattened; leaflets 7-9 (-11), usually narrow; husk very thin, splitting slightly more than half-way; meat very bitter; bark tight. . . . . 2. Bitternut hickory, *C. cordiformis*
1. Buds brown or gray, not scurfy, though sometimes with some yellow scales; meats usually sweet. 2
   2. Teeth (many of them) of leaflets with dense subterminal tufts of hairs; leaflets 5, rarely 7; overwintering terminal buds rather slender, 13-22 mm. long, the outer dark brown bud-scales persistent; husk of fruit very thick, splitting to base; nuts white, angled, thin-shelled; bark of older trees shaggy. . . . . 3. Shagbark hickory, *C. ovata*

2. Teeth glabrous or ciliate, without special tufts of hairs; nuts thick-shelled. 3
   3. Leaflets 5-9, fascicled-hairy (tomentose) beneath; branchlets stout; twigs and rachises of leaves often fascicled-hairy; overwintering terminal buds 10-15 mm. long, subglobose, the outer dark bud-scales finally deciduous, so buds gray silky-hairy; husk medium thick, splitting to base; nuts brown, angled; bark tight, furrowed. ....1. Mockernut hickory, *C. tomentosa*
   3. Leaflets 5-7, glabrous or rarely hairy beneath; twigs glabrous; rachises of leaves usually glabrous or occasionally densely puberulent; branchlets slender; overwintering terminal buds 7-12 mm. long; husk thin; nuts whitish or light brown, smooth or slightly angled. 4
      4. Fruit dark brown, shining, smooth; husk finally splitting only to middle or sometimes by one suture to near base; petiole not red; buds not yellow-dotted; lower leaflet surfaces inconspicuously yellow-dotted; terminal bud slender, pointed, the outer dark brown scales persistent or deciduous; bark tight. .... 4. Pignut hickory, *C. glabra*
      4. Fruit light brown, dull, warty; husk finally splitting to base, hence immature fruit 4-ridged to base; petiole often red; overwintering terminal buds subglobose, essentially blunt, the outer dark bud-scales finally deciduous, the bud then gray, silky-hairy; lateral buds and lower leaflet surfaces conspicuously yellow- and brown-dotted; bark of older trees usually shaggy or loosely scaly. .... 4. Sweet pignut, Red hickory, *C. ovalis*

1. *Carya tomentosa* (Poir.) Nutt., mockernut hickory

As noted above, this species has had the greatest errors in published descriptions of ranges and especially in the

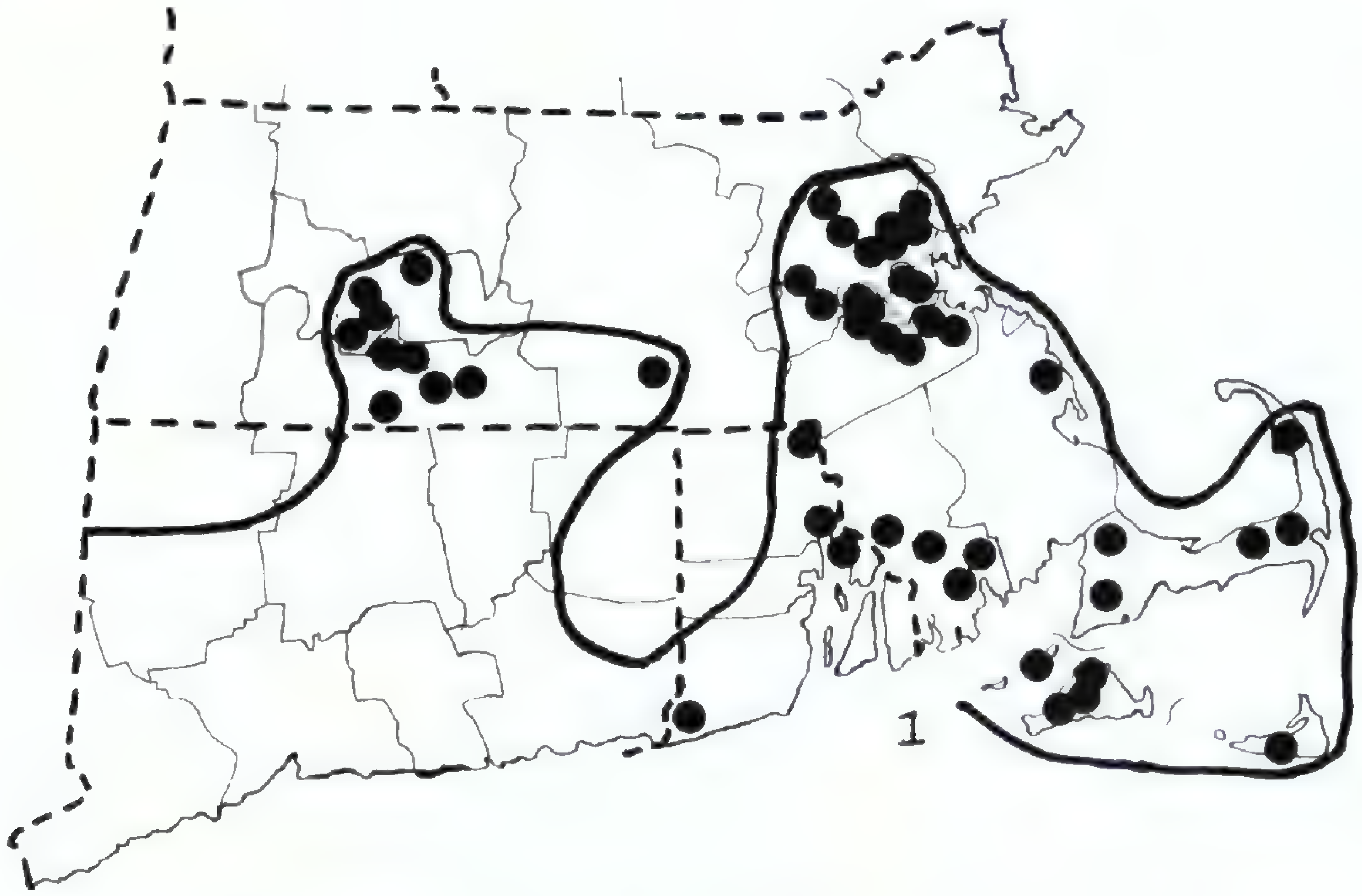
maps. This is due in large part to the fact that the name *Carya alba* has been used by some botanists for mockernut, by others for shagbark. The name is now dropped as a "nomen confusum". Most maps showing clear ranges such as Little (1965), Hough (1907), Jaques (1941), and Harlow (1958) indicate the mockernut as occurring in New Hampshire and Vermont. Most older floras of Vermont (Burns and Otis, 1916, Dole, 1937), report the species in Vermont. However, the northernmost New England known records are in Middlesex and Hampshire (Mt. Warner, North Hadley) Counties, Massachusetts. All records mentioned north of Massachusetts are based on incorrect identification. Strangely enough, the distribution given by Sargent (1933) was essentially correct, and more recent publications have confused the situation. Specimens are here reported from Cape Cod (Barnstable Co., Mass.) but are not shown by Little.

Massachusetts: MIDDLESEX CO.: Arlington, N; Belmont, N; Concord, N; Framingham, N; Lincoln, N; Medford, N; Natick, N; Wakefield, N; Waltham, N. SUFFOLK CO.: Boston, N. NORFOLK CO.: Braintree, N; Brookline, N; Canton, N; Dover, N; Milton, N; Needham, N; Norwood, N; Wellesley, N. PLYMOUTH CO.: Marshfield, N. BRISTOL CO.: Dartmouth, N; Fall River, N; New Bedford, N; Swansea, N. BARNSTABLE CO.: Barnstable, WM; Bourne, N; Brewster, N; Dennis, N; Falmouth, N; Sandwich, WM; Wellfleet, N. DUKES CO.: Elizabeth Islands, N; Martha's Vineyard: Chilmark, G, N; Tisbury, N; West Tisbury, G. NANTUCKET CO.: Nantucket Id., G, N. WORCESTER CO.: Oxford, C. HAMPSHIRE CO.: Easthampton, WM; Hadley, G, S, WM; Northampton, WM; Southampton, G, WM.

Maps 1 and 5 show the presently known distribution of the mockernut in New England. This may be stated verbally as: eastern Massachusetts (Middlesex Co. to Cape Cod, Martha's Vineyard, Nantucket) and Connecticut River Valley in Massachusetts (Hampshire and Hampden Co.), Rhode Island and Connecticut. It is absent in Maine, Vermont, New Hampshire, most of central and western Massachusetts.

2. *C. cordiformis* (Wang.) K. Koch, bitternut hickory.

Most maps and descriptions of ranges are essentially



Map 1. Distribution of *Carya tomentosa* in central New England, limits indicated by heavy solid line. A dot designates one or more specimens collected in the town located there.

correct for New England. A few of these report the species in Maine, central New Hampshire and central Vermont. No records are now known of these areas, and probably the maps are merely generalized. My studies show that the bitternut has a somewhat broader distribution in New Hampshire and Vermont than shown by Little. No specimens, however, have been located for the region next to Canada in northwestern Vermont.

Vermont: CHITTENDEN CO.: Burlington, V; Charlotte, G, V; Richmond, H, N, V; South Burlington, V. ADDISON CO.: Middlebury, V; Panton, N, V. RUTLAND CO.: Brandon, N, S, V; Castleton, N, V; Ira, N, V; Poultney, H, N, NH, V; Rutland, G, H; Sudbury, N; Wallingford, G; Wells, N, V. BENNINGTON CO.: Arlington, N, V; Dorset, V; Pownal, V; Shaftsbury, N, V. CALEDONIA CO.: Peacham, H. ORANGE CO.: Bradford, H, N, NH, V; Newbury, H, N, NH, V; Thetford, H, N, V. WINDSOR CO.: Hartland, G, H, N, NH, V; Norwich, NH; Springfield, N, V; Weathersfield, N, V., Windsor, WM. WINDHAM CO.: Brattleboro, N, V; Guilford, V, WM; Newfane, N, NH, V; Vernon, N, NH, V.

New Hampshire: GRAFTON CO.: Hanover, H, N, V; Haverhill, H, N, NH. V; Lebanon, H, N; Orford, NH. SULLIVAN CO.: Charlestown,

N, V; Claremont, WM; Plainfield, NH. CHESHIRE CO.: Alstead, N, V; Chesterfield, N, V; Hinsdale, H, N, NH, S, V; Keene, N, NH, V; Marlboro, H, N, NH, V; Surry, NH; Swanzey, H, N, NH, V; Walpole, G, H, N, NH, V; Westmoreland, N, NH, V; Winchester, H, N, NH, V. STRAFFORD CO.: Durham, NH; Lee, NH. ROCKINGHAM CO.: Exeter, N; Kensington, NH; Newmarket, NH; South Hampton, NH. HILLSBORO CO.: Hollis, NH.

Massachusetts: ESSEX CO.: Andover, G, N; Ipswich, N. MIDDLESEX CO.: Belmont, N; Cambridge, N; Medford, N; Winchester, N. SUFFOLK CO.: Revere, N. NORFOLK CO.: Bellingham, N; Brookline, G, N; Dedham, G, N; Milton, N; Norfolk, N, S; Quincy, N. BRISTOL CO.: Fall River, N; Swansea, N; Westport, N. PLYMOUTH CO.: Hingham, N. WORCESTER CO.: Boylston, MS; Leicester, N; Millbury, C, N; Paxton, C; Princeton, C, N; Spencer, WM; Worcester, C, N. FRANKLIN CO.: Buckland, WM; Montague, N; Sunderland, N, V; Whately, N. HAMPSHIRE CO.: Easthampton, S; Hadley, WM; Hatfield, WM; Huntington, WM; Northampton, WM; Westhampton, WM; Williamsburg, S. HAMPDEN CO.: Chicopee, WM; Holyoke, S; Springfield, WM. BERKSHIRE CO.: Lanesboro, N; Sheffield, G, N; West Stockbridge, N.

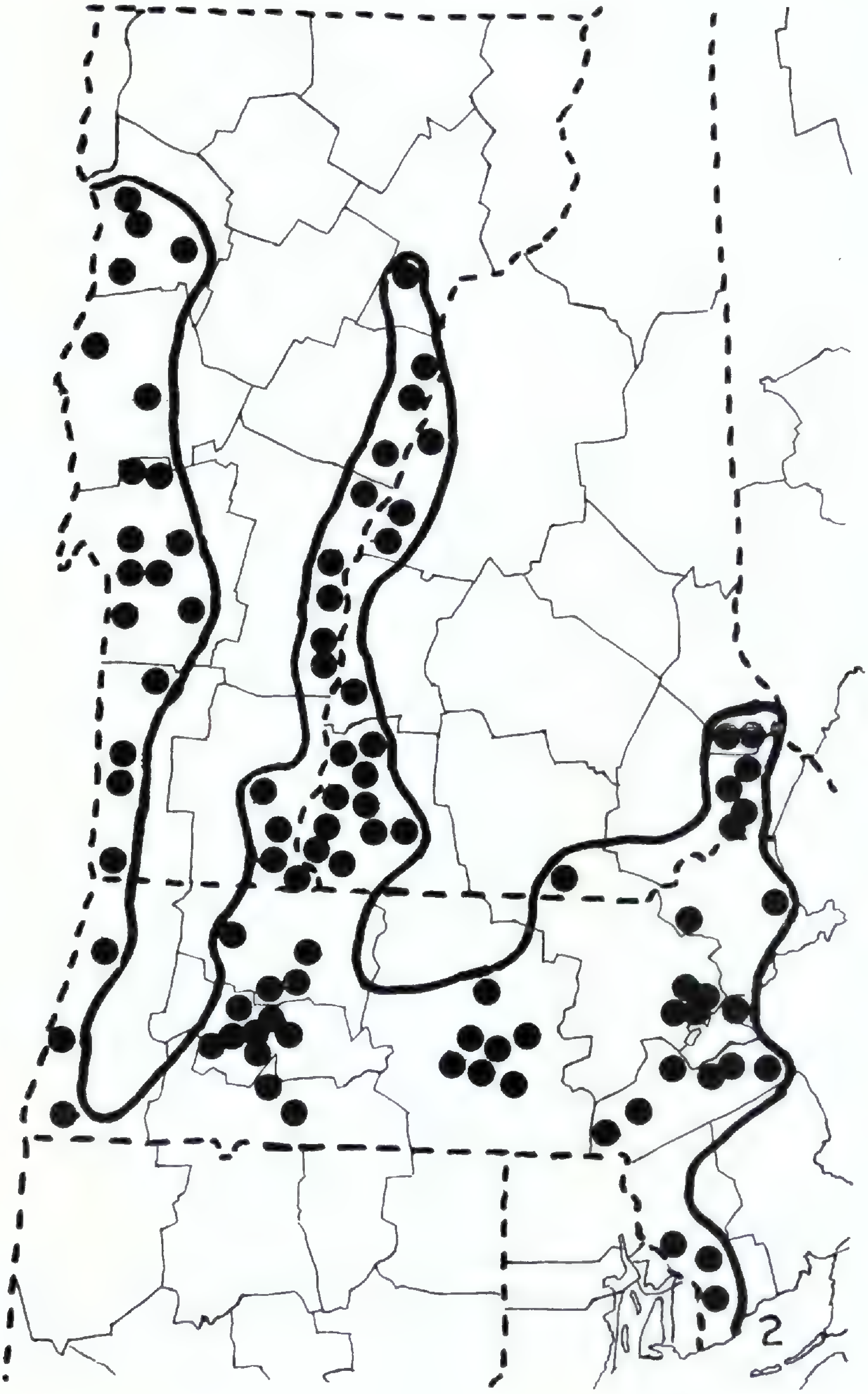
Maps 2 and 6 show the presently known distribution of the bitternut in New England. This may be expressed verbally as: southeastern New Hampshire (to southern Strafford Co.), western New Hampshire and eastern Vermont in the Connecticut River Valley (to Haverhill, N.H. and Peacham, Vt.), western Vermont (north to Burlington), Massachusetts (except for most of Plymouth Co., Cape Cod, Martha's Vineyard, Nantucket, Berkshire Hills), Rhode Island(?) and Connecticut. It is absent in Maine, in central Vermont and central New Hampshire. Seymour (1969) reports the species from the towns of Cumberland and Tiverton in Rhode Island; however, R. L. Hauke, E. A. Palmatier and R. L. Champlin (personal communications) state that the tree does not seem to be native in the state, though it is escaping from cultivation in Kingston.

3. *C. ovata* (Mill.) K. Koch, shagbark hickory.

Most maps and descriptions of ranges are essentially correct for this species. Some of these locate the shagbark

---

Map 2. Distribution of *Carya cordiformis* in northern and central New England, limits indicated by heavy solid line. A dot designates one or more specimens collected in the town located there.


2

in northern and central parts of New Hampshire and Vermont or perhaps all of these states, but again these distributions may merely be highly generalized. Seymour (1969) and Little (1965) record the tree on Cape Cod. I have seen the specimen involved and it is *C. ovalis.* Despite the absence of the shagbark on Cape Cod, it occurs on Nantucket Island. There is a possibility that the trees there are planted, but Maria Owen (1888) reported the species as there a long time ago. Mackeever (1968) does not mention the shagbark on the island, though there is a specimen at the N. Y. Botanical Garden. I have seen only one specimen of *C. ovata* in Berkshire Co., but Hoffman (1922) reports the species as, "rich woods, open hillsides, common in the valley". My studies show that the shagbark occurs slightly further north in New Hampshire and Vermont than indicated by Little. The northernmost record for New Hampshire, Groton, in Grafton Co., is based on the observation of Dr. Robert Zimmerman when he was making an intensive study of the northern distribution of the oaks; he did not collect specimens of the hickory.

As I have observed them, the trees are quite rare toward the north in the Connecticut River Valley, often represented by one to few trees in one locality for a whole town; thus it is very easy to miss a record for a town.

Vermont: CHITTENDEN CO.: Burlington, N, V; Charlotte, G; Colchester, V; Milton, N; Shelburne, N; South Burlington, V; Williston, H. ADDISON CO.: Cornwall, V; Ferrisburg, G, N; Middlebury, V. RUTLAND CO.: Brandon, H; Castleton, H, N, NH, V; Fair Haven, G; Ira, H, N, NH, V; Poultney, H, N, NH, V; Rutland, H; Sudbury, N; Wells, H, N, NH, V; West Haven, V. BENNINGTON CO.: Arlington, WM; Pownal, N, NH, V; Shaftsbury, WM; Sunderland, WM. WINDSOR CO.: Springfield, WM; Weathersfield, Z; Woodstock, H. WINDHAM CO.: Brattleboro, N; Guilford, WM; Newfane, H, NH, N, V; Townshend, N; Vernon, WM.

New Hampshire: GRAFTON CO.: Groton, Z. SULLIVAN CO.: Charlestown, NH, WM. Claremont, WM. CHESHIRE CO.: Chesterfield, WM; Hinsdale, H, N, NH, S, V; Keene, H, N, NH, V; Marlboro, H, N, NH, V; Richmond, N, WM; Swanzey, H, N, NH, S, V; Westmoreland, H, N, NH, V; Winchester, G, N, NH, V. CARROLL CO.: Wolfeboro, NH. BELKNAP CO.: Alton, NH; Gilmanton, NH; Meredith, N; Sanbornton, N. STRAFFORD CO.: Dover, NH; Durham, NH; Farmington, NH; Lee, N;

Middleton, NH; Milton, NH; Rochester, N, NH. MERRIMACK CO.: Warner, N, NH. ROCKINGHAM CO.: Atkinson, N; Derry, N, NH; Fremont, N; Hampton Falls, N; Kensington, N; Nottingham, N; Stratham, N. HILLSBORO CO.: Amherst, N; Hancock, H, N, NH, V; Hillsboro, N; Mason, G, H, N; Merrimack, G, N.

Maine: OXFORD CO.: Brownfield, MN; Paris, G, MN; Rumford, MN. CUMBERLAND CO.: Brunswick, MN; Cape Elizabeth, N, NH; Cumberland, G, N, NH, S; North Yarmouth, N, NH; Westbrook, G, NH. YORK CO.: Buxton, N; Eliot, N; Kittery, G, MN, N; Limington, N; North Berwick, G, N; Old Orchard, N; Saco, N; Sanford, MN; South Berwick, MN, N; Wells, N; York, G, MN, N. ANDROSCOGGIN CO.: Livermore Falls, N; Turner, MN, N. SAGADAHOC CO.: Arrowsic, MN, NH; Bowdoinham, MN; West Bath, N; Woolwich, MN. SOMERSET CO.: planted?: Solon Village, MN; St. Albans, MN. KENNEBEC CO.: planted?: Augusta-Chelsea town line, MN; Clinton, N; Fayette, NH; Manchester, N; Winthrop, MN.

Massachusetts: ESSEX CO.: Andover, G, N; Essex, N; Haverhill, N; Ipswich, G, MS; Methuen, N. SUFFOLK CO.: Boston, G, N; Revere, G, N. MIDDLESEX CO.: Ashby, N; Belmont, G; Cambridge, N; Concord, N; Groton, N; Malden, N; Medford, N; Pepperell, N; Tewksbury, N; Townsend, N; Wakefield, N; Woburn, N. NORFOLK CO.: Canton, N; Milton, N; Needham, N; Norfolk, S; Norwood, G; Wellesley, G. BRISTOL CO.: Dighton, N. PLYMOUTH CO.: Kingston, WM, NANTUCKET CO.: Nantucket Id., N. WORCESTER CO.: Auburn, C; Barre, C, MS; Boylston, C; Charlton, C, N; Dudley, C; Hardwick, C, MS; Harvard, C; Holden, C, N; Lancaster, C; Leicester, C; Leominster, N; Lunenburg, N; Millville, C; New Braintree, C; Northboro, C; Northbridge, C; North Brookfield, C; Oakham, C; Oxford, C; Petersham, C; Princeton, C, N; Royalston, N; Rutland, C, N; Shrewsbury, C, N; Southbridge, C; Spencer, C, N; Sutton, C; Upton, C; Westboro, C, N; West Boylston, C; Worcester, C, MS. FRANKLIN CO.: Buckland, WM; Charlton, MS, N; Deerfield, N, V; Gill, WM; Greenfield, WM; Montague, MS, N, V; New Salem, N; Northfield, WM; Orange, MS, WM; Shelburne, N; Sunderland, MS. HAMPSHIRE CO.: Amherst, MS, N; Belchertown, MS; Easthampton, WM; Enfield, MS; Granby, MS: Hadley, WM; Hatfield, MS; Northampton, G, MS, N, S, V; South Hadley, S; Williamsburg, S. HAMPDEN CO.: Granville, G, MS; Holyoke, G, MS; Russell, N; Springfield, N. BERKSHIRE CO.: Sheffield, G, MS.

The records in Kennebec and Somerset counties, Maine are from the University of Maine herbarium, though Hyland and Steinmetz (1944) state that the shagbark is locally planted in the following counties: s. Penobscot, Piscataquis, s. Somerset, c. Oxford, sc. Hancock, ec. Waldo, nw. Knox, e. Kennebec.

Maps 3 and 7 show the presently known distribution of the shagbark in New England. This may be expressed verbally as: southwestern Maine (as far as Sagadahoc and southern Oxford counties) southeastern New Hampshire (as far as southeastern Grafton Co.), along the Connecticut River Valley in southwestern New Hampshire and southeastern Vermont (as far as southern Sullivan Co., N.H. and Windsor Co., Vt.), western Vermont (as far north as Burlington), most of Massachusetts (except Cape Cod, Martha's Vineyard, and Berkshire Hills), Connecticut and Rhode Island. The shagbark is absent in most of central New Hampshire, central Vermont; it is found on Nantucket Island, Mass.

4. *C. glabra-ovalis* complex, pignut hickories [*C. glabra* (Mill.) Sweet, *C. ovalis* (Wang.) Sarg.]

Carya glabra and *C. ovalis* have been treated by some authors (Sargent, 1933, Fernald, 1950, Gleason 1952, Seymour, 1969, 1970) as separate species, by others (Robinson and Fernald, 1908, Little, 1953, 1969) as a single species, *C. glabra*. In any case there is tremendous variation in bark, fruit shape, leaves. Thus Sargent, 1933, and especially Steyermark, 1963, not only recognize both species but also a number of varieties and forms under each of the two, based primarily on shape of the fruit; there are also pignuts with hairy leaves. At the present time I am recognizing two species, realizing that there seem to be intergradations (hybridization?) in certain features in some localities. I have not decided which varieties to recognize. The herbarium specimens of New England pignut hickories are extremely unsatisfactory: often only flowering material, or sterile early summer material or poorly collected material without notes on bark. As already stated (Manning, 1950) one needs all possible features for separation of the species, typical leaves (early and late summer condition), true terminal buds in fall condition, mature fruit (preferably after fruit has fallen on the ground), and notes on bark. It is sometimes possible to

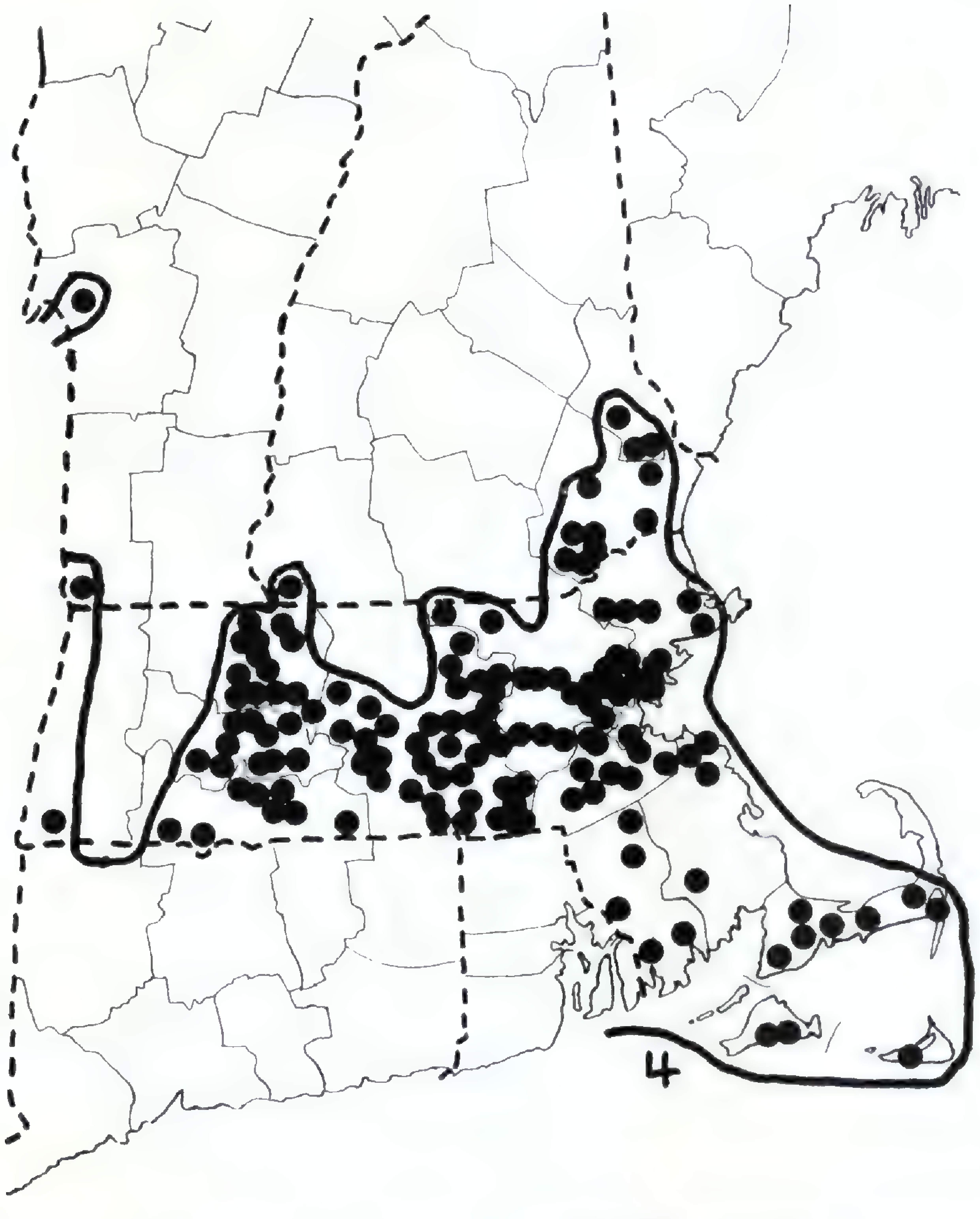
Map. 3. Distribution of *Carya ovata* in northern and central New England, limits indicated by heavy solid line. A dot designates one or more specimens collected in the town located there. The half dots in northern Maine designate towns where specimens have been collected but the trees were probably planted, not native.

name well collected specimens in summer, sterile or fruiting, but in other cases it is nearly impossible.

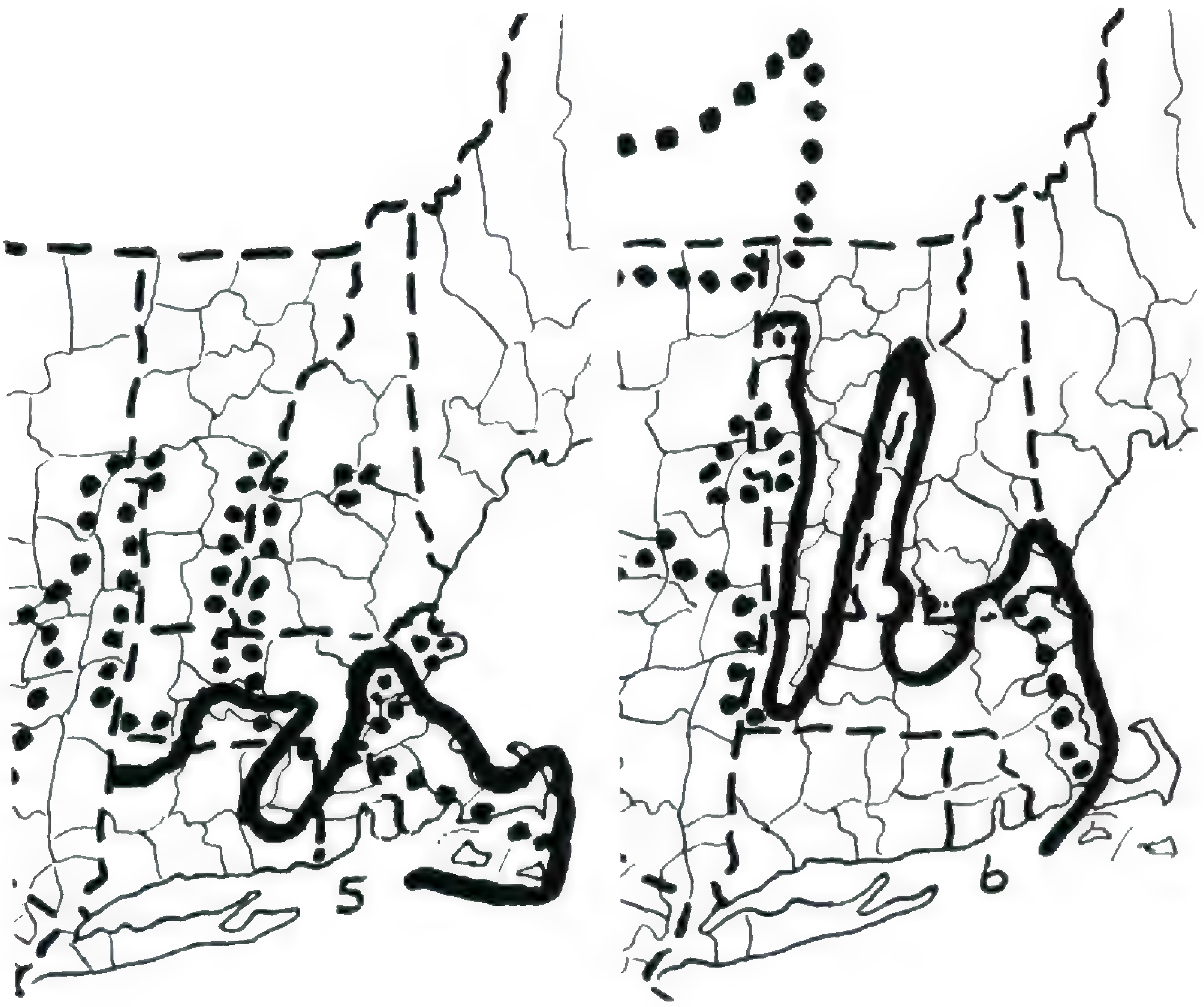
Considering the condition of the specimens available at the present time, for this study I am using the term *Carya glabra-ovalis* complex in order to give a general view of the distribution. Futhermore, in a great many cases the ranges seem to overlap, so this distribution may represent the distribution of each species. In the list of towns I have indicated by "g" and "o" the name given on the herbarium label, but this does not always have significance. I will use the term pignut for both.

There is a wide variation in books with respect to the distribution of the pignuts in New England, whether the treatments represent one or both species. Many of the older books report pignuts as rather common in eastern and western Vermont. Most of these records are based on incorrect identification. Little's (1965, 1971) maps are much more accurate reducing the localities to 2 in western and one in southeastern Vermont. However, I have travelled extensively through southeastern Vermont and have failed to find any pignuts there. I have found pignuts close by on 2 hills in southwestern New Hampshire and on one in northern Massachusetts (north of Bernardston) just 2 miles south of the Vermont border. Little's maps do not show the pignuts found rather recently by Hodgdon in southeastern New Hampshire, nor those which occur on Martha's Vineyard and Nantucket Island.

In western New Hampshire and all of Vermont, pignuts are located on only 4 isolated rather low hills, in general between 600 and 1000 feet elevation. The trees do not seem to occur on longer ridges or at higher elevation or in the valleys. On at least 2 of these hills, Meetinghouse Hill, Winchester, N.H. and Coon Hill near Lake Bomoseen, Rutland Co., Vt., the trees are very numerous near the top. On a third, Television Station Hill, Winchester, N.H., the few large trees near the top seem to be dying out. Very few hills of the numerous hills in the two states have been



Map 4. Distribution of *Carya glabra-ovalis* complex in northern and central New England, limits indicated by heavy solid line. A dot designates one or more specimens collected in the town located there.



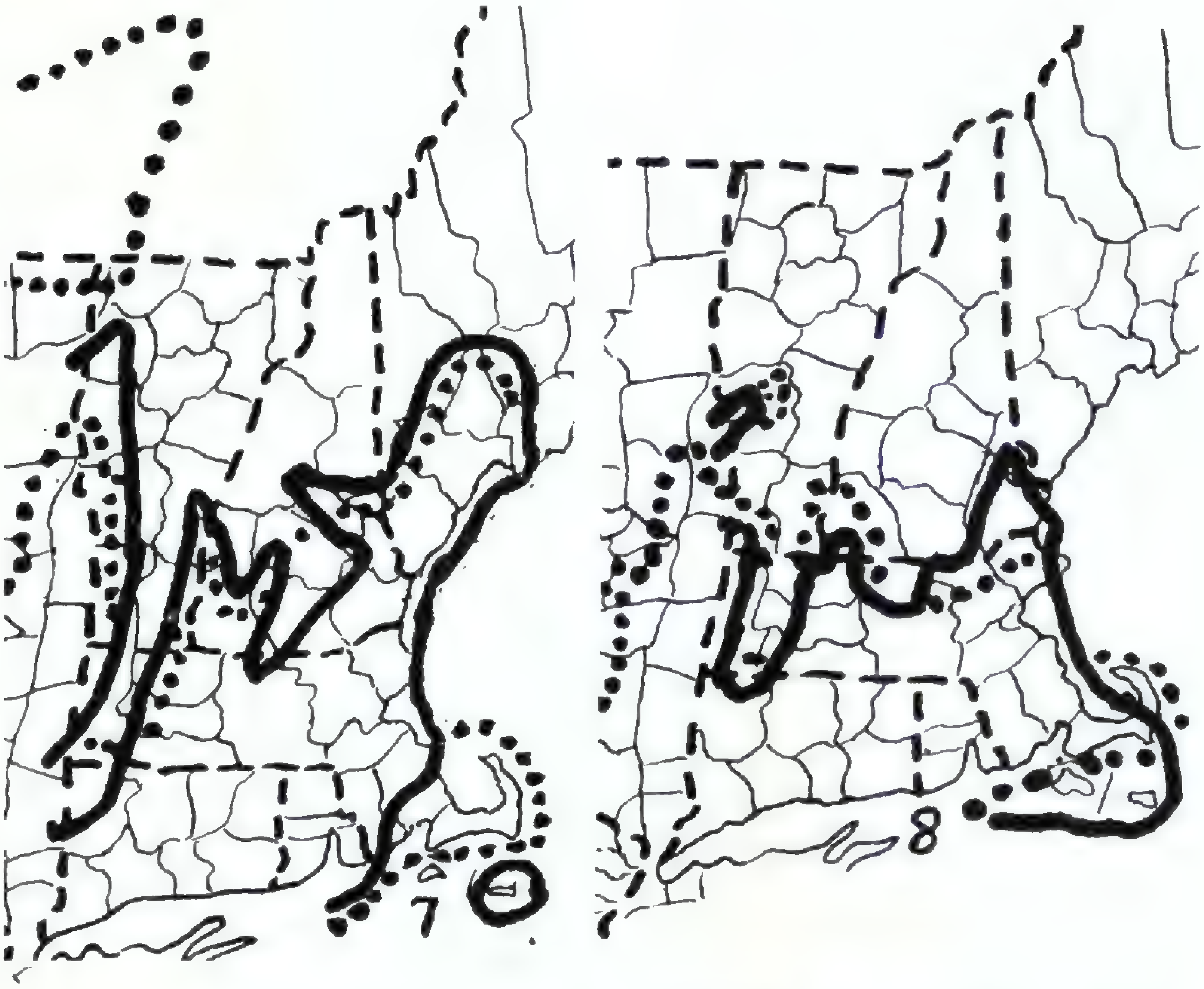
Maps 5, 6. Distribution in New England and adjacent areas of *Carya tomentosa* and *C. cordiformis* respectively according to Little (1965, 1971), his limits indicated by a dotted line where they differ from mine, my corrections indicated by a heavy solid line.

climbed in an attempt to locate hickories, and it is very possible that other hills with pignuts will be found.

Vermont: RUTLAND CO.: Castleton, g, o: G, H, MS, N, NH, V, WM. BENNINGTON CO.: Pownal, g: G; o: H, MS, N, NH, V, WM.

New Hampshire: CHESHIRE CO.: Winchester, g: N, WM; o: N, V, WM. STRAFFORD CO.: Barrington, o: N, NH; Durham, o: N, NH; Lee, o: N, NH. ROCKINGHAM CO.: Atkinson, o: N, NH; Derry, o: N, NH; Hampstead, g: NH; New Market, g: NH; Raymond, o: N, NH; Salem, g: NH; South Hampton, g: NH; Windham, g: NH. HILLSBORO CO.: Pelham, g, o: N, NH.

Massachusetts: ESSEX CO.: Andover, g: N; Boxford, o: N; Ipswich, g: N; Lynn, g: WM; Manchester, g: N; North Andover, o: NH; Saugus, o: N. SUFFOLK CO.: Boston, g, o: G, N; Revere, g: N. MIDDLESEX CO.: Acton, o: WM; Arlington, o: N; Ashby, g:



Maps 7, 8. Distribution in New England and adjacent areas of *Carya ovata* and *C. glabra-ovalis* complex respectively according to Little (1965, 1971), his limits indicated by a dotted line where they differ from mine, my corrections indicated by a heavy solid line.

WM; Belmont, g: N; Boxboro, g: N; Cambridge, g, o: N; Concord, g, o: N; Framingham, o: N; Lexington, g, o: G, N; Lincoln, g, o: N, WM; Medford, g, o: N; Melrose, g: N; Natick, g: N; Newton, o: N; Pepperell, o: NH; Reading, g: N; Stoneham, g: N; Wakefield, g: N; Waltham, o: N; Woburn, g, o: N. PLYMOUTH CO.: Hingham, o: N; Middleboro, g: N; Norwell, g: N. NORFOLK CO.: Canton, g, o: G, N; Cohasset, g, o: G, N; Medfield, o: N; Milton, g, o: G, N, S; Needham, g: N; Norfolk, g, o: N, S; Norwood, g: G; Walpole, g: G; Wellesley, g: G; Weymouth, o: N. BARNSTABLE CO.: Barnstable, g, o: N, WM; Brewster, g, o: G, N; Chatham, o: N; Falmouth, o: N; Mashpee, g: WM; Sandwich, g: WM; Yarmouth, o: N. DUKES CO.: Martha's Vineyard: Edgartown, o: N; West Tisbury, g: G, N. NANTUCKET CO.: Nantucket Id., o: N. BRISTOL CO.: Easton, g, o: G; New Bedford, g: N; Swansea, o: N; Taunton, g: N; Westport, o: N. WORCESTER CO.: *C. glabra:* Bolton, C, N; Charlton, N; Hardwick, C; Lancaster, G; Leominster, C; Lunenburg,

N; Mendon, C; Milford, C; Millbury, C; Sutton, C; Worcester, C, N. *C. ovalis:* Auburn, C; Barre, WM; Berlin, C; Blackstone, C; Boylston, C; Brookfield, C; Douglas, C; Holden, C; Harvard, C; Leicester, C; Lunenburg, N; New Braintree, C; Northboro, C; North Brookfield, C; Millville, C; Oakham, S, WM; Oxford, C; Paxton, C; Petersham, C, MS, WM; Shrewsbury, C; Southboro, C, N; Sterling, C, N; Sutton, C; Upton, C; Uxbridge, C; Webster, C; Westboro, C; West Boylston, C; West Brookfield, C; Worcester, G. FRANKLIN CO.: Bernardston, o: MS, N, V; Deerfield, g, o: G, N, V; Erving, g: N; Gill, o: N, V, WM; Greenfield, g, o: MS, N, S, V; Leverett, g: WM; Montague, o: N, V; Northfield, g: N, V; New Salem, o: N; Sunderland, g, o: MS, N, WM; Whately, g: N. HAMPSHIRE CO.: Amherst, o: WM; Belchertown, o: M, WM; Easthampton, o: S, WM; Granby, g: S; Hadley, g, o: S, WM; Hatfield, o: WM; Northampton, g. o: A, G, MS, WM, V; South Hadley, o: WM; Westhampton, g: S, WM. HAMPDEN CO.: Chicopee, g: N; Granville, g: G, MS, N; Holyoke, g. o: S, WM; Ludlow, g: MS; Southwick, g, o: N; Springfield, g, o: MS, N; Wales, o: N; Wilbraham, o: MS. BERKSHIRE CO.: Sheffield, g, o: G, H, N.

Maps 4 and 8 show the presently known distribution of the pignuts in New England. This may be expressed verbally as southeastern New Hampshire, extreme southwestern New Hampshire, west central and extreme southwestern Vermont, most of Massachusetts (except Berkshire Hills), Rhode Island and Connecticut. It is not reported from Maine, eastern Vermont, nor most of New Hampshire and Vermont.

LITERATURE CITED

BEAN, R. C., C. H. KNOWLTON, A. F. HILL. 1956. Eleventh report of the committee on plant distribution. Rhodora 58: 125-134.

BLAKESLEE, A. F. and C. D. JARVIS. 1911. New England trees in winter. Storrs, Conn.

BURNS, C. P. and C. H. OTIS. 1916. The trees of Vermont. Vt. Agr. Exp. Sta. Bull. 194, Burlington, Vt.

DOLE, E. J., ed. 1937. The flora of Vermont, 3rd rev. ed. Burlington, Vt.

FERNALD, M. L. 1950. Gray's Manual of botany, 8th ed. New York.

GLEASON, H. A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. New York.

HARLOW, W. M. and E. S. HARRAR. 1958. Textbook of dendrology, 4th ed. New York.

HOFFMAN, R. 1922. Flora of Berkshire Co., Mass. Proc. Boston Soc. Nat'l. Hist. **36**: 171-382.

HOUGH, R. B. 1907. Handbook of the trees of northern states and Canada. New York.

HYLAND, F. and F. H. STEINMETZ. 1944. Woody plants of Maine. Orono, Me.

JAQUES, H. E. 1941. How to know the trees. Mt. Pleasant, Iowa.

LANJOUW, J. and F. A. STAFLEU. 1964. Index Herbariorum, part 1. Herbaria of the world, 5th ed. Regnum Vegetabile 31. Utrecht, Netherlands.

LITTLE, E. L., JR. 1953. Check list of native and naturalized trees of the United States. Agriculture Handbook no. 41. Washington, D.C.

————————. 1965. Distribution range maps, in FOWELLS, H. A., Sylvics of forest trees of the United States. Agr. Handbook no. 271. Washington, D.C.

————————. 1969. Two varietal transfers in *Carya* (hickory). Phytologia **19**: 186-190.

————————. 1971. Atlas of United States trees. Vol. 1. Conifers and important hardwoods. U.S.D.A. Forest Service, Misc. Publ. no. 1146.

MACKEEVER, F. C. 1968. Native and naturalized plants of Nantucket. Amherst, Mass.

MANNING, W. E. 1950. A key to the hickories north of Virginia with notes on the two pignuts, *Carya glabra* and *C. ovalis*. Rhodora **52**: 188-199.

OWEN, M. L. 1888. A catalogue of plants growing without cultivation in the county of Nantucket, Mass. Northampton, Mass.

ROBINSON, B. L. and M. L. FERNALD. 1908. Gray's new manual of botany. 7th ed. New York.

SARGENT, C. S. 1933. Manual of the trees of North America. 2nd ed., rev. Boston.

SEYMOUR, F. C. 1969. The flora of New England. Rutland, Vt.

————————. 1970. The flora of Vermont. Burlington, Vt.

STEYERMARK, J. A. 1963. Flora of Missouri. Ames, Iowa.

BOTANICAL LABORATORY
BUCKNELL UNIVERSITY
LEWISBURG, PENNSYLVANIA 17837

BENTHIC ALGAE AND VASCULAR PLANTS OF THE LOWER MERRIMACK RIVER AND ADJACENT SHORELINE

Arthur C. Mathieson and Richard A. Fralick[1]

Introduction

The present investigation was initiated as a part of a broad ecological study of the Merrimack River Estuary in Massachusetts (Miller, *et al.*, 1971). The project was conducted by Normandeau Associates for the U. S. Army Corps of Engineers in order to predict the biological effects of a possible fresh water diversion on the ecology of the Estuary. Jerome, *et al.* (1965) have evaluated the marine resources of the Estuary, but they have conducted only limited botanical studies. In the present account we summarize the composition and distribution of seaweeds and vascular plants from the Merrimack River Estuary. A comparison with the algal species diversity in the Hampton-Seabrook and the Great Bay Estuary Systems of New Hampshire is also given.

Collections and observations of intertidal algae and vascular plants were made at 19 stations in the Merrimack River Estuary during the summer and fall of 1971 (Fig. 1). Vascular plants were studied at 15 stations (Table I), while algae were studied at 13 locations (Table II). Representative specimens of plants from each site were collected and have been deposited as voucher specimens in the Herbarium of the University of New Hampshire (NHA). The type and quantity of substrate available for benthic plants at each site were noted. The nomenclature of the Second Revised British Checklist (Parke and Dixon, 1968) was applied for most taxa of seaweeds, while the Eighth Edition of Gray's Manual (Fernald, 1950) was employed for vascular plants.

[1]Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution Number 635.

The breakwater at station 1 provides the maximum amount of stable substrate for benthic organisms. The intertidal areas at the remaining stations are composed primarily of scattered rock outcrops, boulders, pebbles and junk, interspersed with sand or mud. The largest amount of solid rock is usually evident in the upper intertidal zone and the substrate tends to grade into sand-mud in the lower shore. From the mouth of the river to station 11 there is a reduction in the amount of rock (particularly large outcrops) and a progressive increase in the deposition of mud on the shore. A buildup of extensive peat-like material is evident in the upper intertidal zone at many stations throughout the estuary, where the roots of *Spartina* spp. stabilize muddy surfaces and allow colonization of seaweeds, vascular plants and invertebrates.

Miller, *et al.* (1971) summarized the salinity distribution in the Merrimack River Estuary. A typical gradient is evident, with maximum salinities of 30 o/oo or higher on the open coast at Salisbury Beach and fresh water upstream near stations 18 and 19. Brackish waters are found between the two extremes. Salinity encroachments at open coastal levels occur from 2 to about 5 miles upstream, depending upon the season. At high tide the limits of salt intrusion vary from 4.3 to 10.9 miles from the mouth; they range from 3.1 to 6.8 miles at low tide. Gross fluctuations of temperature and salinity are evident (both daily and seasonally) at any site, particularly in the intermediate brackish water areas.

Vascular Plants

Thirty-one taxa of vascular plants were found in the marshy habitats of the Merrimack River Estuary (Table I). A fairly uniform distribution of salt-marsh plants was apparent from stations 4 to 12. Species consistently present included *Solidago sempervirens*, *Spartina alterniflora*, *S. patens*, *Salicornia europaea*, *Atriplex patula* and *Limonium carolinianum*. Station 13 was characterized

by a diminished salt-marsh flora. New associations were present at stations 16 and 17 in the form of *Scirpus validus*, *Scrirpus maritimus*, *Acorus calamus* and *Zizania aquatica*. These four species are essentially brackish to freshwater inhabitants and represent a marked change in association away from some of the more persistent halophytes such as *S. alterniflora*, *S. patens*, *Salicornia europaea* and *Solidago sempervirens*. A detailed description of species composition at each station investigated is presented in Table I.

Intertidal Algae

A total of 31 taxa of benthic algae was collected (Table II). Twelve Chlorophyceae (green algae), eleven Phaeophyceae (brown algae) and five Rhodophyceae (red algae) were identified. A detailed evaluation of the Cyanophyceae (blue-green algae), Xantophyceae (yellow-green algae) and Bacillariophyceae (diatoms) was beyond the

---

FIGURE 1

Intertidal Collecting Stations In the Merrimack River Estuary

1. Open ocean side of the breakwater at Salisbury Beach
2. Estuarine side of the breakwater at Salisbury Beach
3. Breakwater near Badgers Rocks
4. Western bank of Plum Island River underneath the bridge connecting Plum Island
5. Black Rock Point
6. Morrill Creek
7. Rocks just upriver from Coffin Point
8. Waterfront at Newburyport just west of the power generating station
9. Twin Rocks, on the Salisbury side of the river
10. North End Boat Club
11. Rock promontory on Ram Island
12. In the main channel on a rocky promontory of Carr Island
13. North side of the river across from Eagle Island
14. Rock promontory at Salisbury Point
15. On the north shore just upriver of the factories
16. On the north shore just upriver of the Seahorse Marina
17. On the south shore just down river of the Artichoke River
18. On the south shore between the Artichoke and Indian Rivers
19. South shore just upriver of the Groveland Bridge

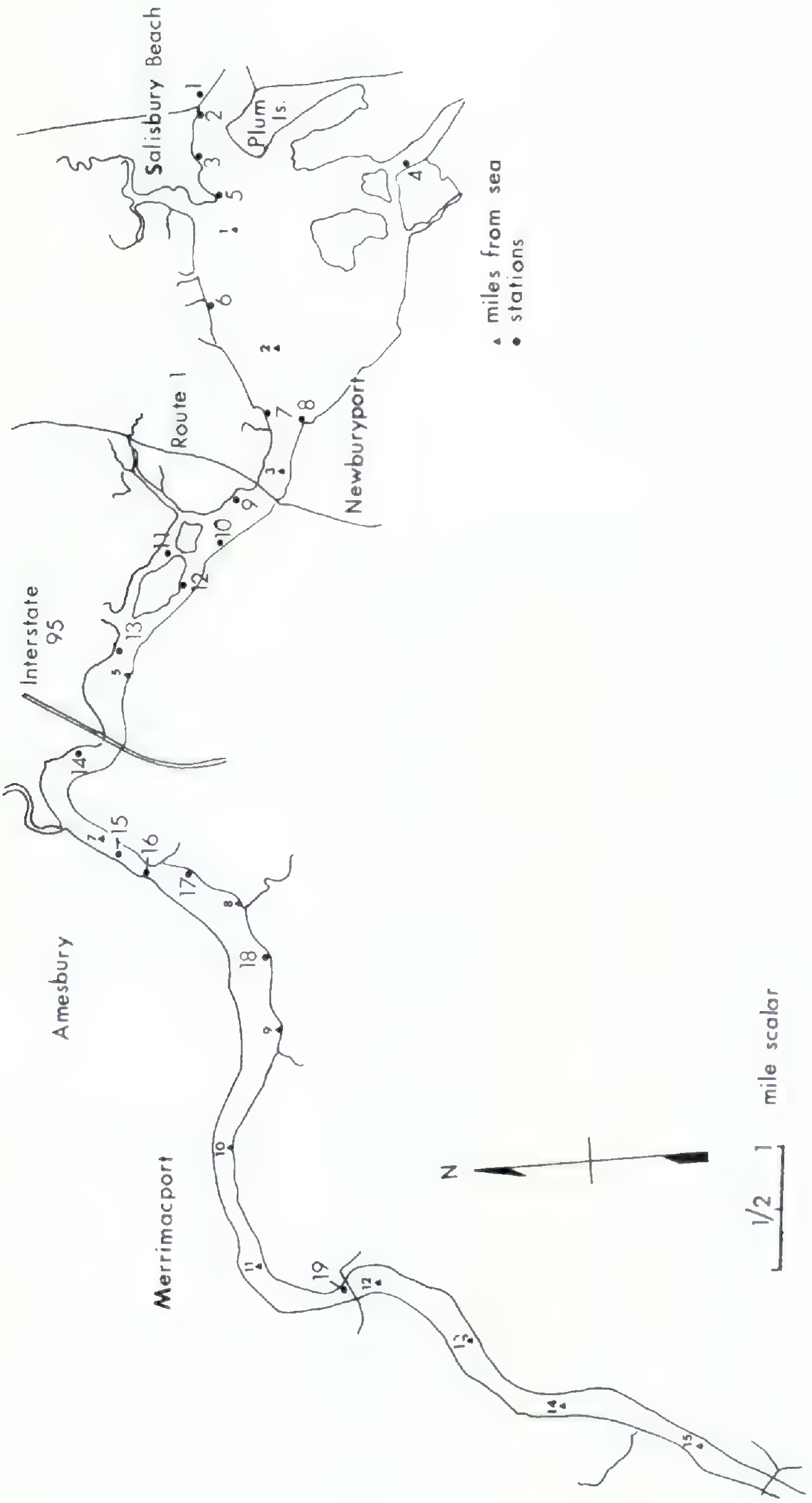

Salisbury Beach
Plum Is.
miles from sea
stations
Route 1
Newburyport
Interstate 95
Amesbury
Merrimacport
N
1/2
1
mile scalar

TABLE I

VASCULAR SHORELINE PLANTS OF THE MERRIMACK RIVER ESTUARY

PLANT	STATIONS 1	2	3	4	5	7	8	9	11	12	13	14	16	17	18
Triglochin maritima								×							
Artemiain stelleriana			×	×											
Artemisia stelleriana			×	×											
Ammophila breviligulata			×												
Solidago sempervirens			×	×	×	×	×	×	×	×		×	×		
Spartina alterniflora				×	×	×	×	×	×	×	×	×	×		
Spartina patens				×	×	×	×	×	×	×	×	×	×		
Salicornia europaea				×	×	×		×		×					
Plantago juncoides				×	×										
Atriplex patula var. *hastata*				×		×	×	×	×	×	×				
Limonium carolinianum				×				×	×	×					
Lythrum salicaria					×				×						
Cakile edentula					×										
Aster novi belgii					×										
Plantago oliganthos					×										
Carex salina					×										
Hudsonia tomentosa					×										

(continued)

TABLE I (continued)

PLANT	STATIONS 1	2	3	4	5	7	8	9	11	12	13	14	16	17	18
Acnida cannabina						×	×	×	×			×	×		
Potentilla egedei var. *groenlandica*						×			×	×	×				
Juncus gerardi						×			×						
Spergularia marina						×									
Eleocharis acicularis						×									
Ranunculus sp.						×									
Scirpus validus								×				×	×	×	×
Scirpus maritimus var. *fernaldi*									×	×		×	×	×	×
Distichlis spicata									×						
Typha latifolia												×	×		
Sium suave													×		
Acorus calamus														×	×
Zizania aquatica														×	×
Polygonum hydropiper														×	
Aster subulatus														×	
TOTAL			4	9	11	11	5	9	11	8	4	7	9	6	4

TABLE II

SPECIES COMPOSITION AND DISTRIBUTION OF CONSPICUOUS INTERTIDAL ALGAE IN THE MERRIMACK RIVER ESTUARY

	STATIONS												
SPECIES	1	2	5	6	7	9	10	11	13	15	17	18	19
CHLOROPHYCEAE:													
Blidingia minima	×	×	×		×	×							
Enteromorpha erecta	×	×	×	×	×	×	×	×	×	×			
Enteromorpha groenlandica					×								
Enteromorpha intestinalis	×	×	×		×	×	×						
Enteromorpha linza	×	×	×	×									
Monostroma oxyspermum					×	×	×						
Pseudendoclonium marinum	×	×	×										
Rhizoclonium riparium							×						
Spongomorpha arcta	×												
Ulothrix flacca	×		×	×									
Urospora penicilliformis		×											
Ulva lactuca	×		×										
SUBTOTAL	8	6	7	3	5	4	4	1	1	1			
PHAEOPHYCEAE:													
Ascophyllum nodosum	×	×	×	×	×								
Ectocarpus confervoides	×												
Elachista fucicola	×												
Fucus vesiculosus	×	×											
Fucus vesiculosus var *spiralis*			×	×	×	×							
Laminaria digitata	×												

(continued)

TABLE II (continued)

SPECIES	STATIONS 1	2	5	6	7	9	10	11	13	15	17	18	19
PHAEOPHYCEAE (continued)													
Laminaria saccharina	×												
Petalonia fascia	×												
Pilaiella littoralis	×		×	×									
Ralfsia verrucosa	×	×											
Scytosiphon lomentaria	×												
SUBTOTAL	10	3	3	3	2	1							
RHODOPHYCEAE:													
Hildenbrandia prototypus	×	×	×		×								
Polysiphonia fibrillosa			×										
Porphyra leucosticta	×												
Porphyra umbilicalis	×												
Ptilota serrata	×												
SUBTOTAL	4	1	2		1								
XANTHOPYCEAE:													
Vaucheria sp.			×	×		×	×	×	×	×	×	×	
SUBTOTAL			1	1		1	1	1	1	1	1	1	
BACILLARIOPHYCEAE:													
Amphipleura rutilans		×	×	×		×							
Melosira sp.								×					
SUBTOTAL		1	1	1		1		1					
TOTAL	22	11	14	8	8	7	5	3	2	2	2	0	0

scope of the present investigation, although some data was collected. For example, the colonial diatom, *Amphipleura rutilans,* was a conspicuous component at stations 2, 5, 6 and 9. *Vaucheria* sp. and various blue-green algae such as *Lyngbya, Oscillatoria* and *Merismopedia* formed a conspicuous mat amongst *Spartina* roots at stations 5, 6, 9, 10, 11, 13, 15 and 17.

Details of species composition and distribution of seaweeds are summarized in Table II. The maximum number of species was found at stations 1, 2 and 5; beyond station 5 there was a rapid and progressive reduction in species numbers. Red algae appeared to be least tolerant of reduced salinities. Three of the five species dropped out at station 2, and no red algae were found beyond station 7. Brown algae showed a wider distribution than red algae, but even so they were not found upstream of station 9, and their largest number of species was found at station 1. Green algae were the most cosmopolitan of the three major groups, with *Enteromorpha erecta* extending to the low salinities of station 15. The yellow-green alga, *Vaucheria* sp., and the green alga, *E. erecta,* were the most widespread of all seaweeds. Several blue-green algae are probably equally tolerant to reduced salinities, but a lack of specific identifications precluded a precise evaluation.

An inspection of Table II indicates that most seaweeds exhibit a cosmopolitan distribution, for they occur both on the open coast and within the estuary. *Vaucheria* sp., *Enteromorpha groenlandica, Monostroma oxyspermum, Fucus vesiculosus* var. *spiralis,* and *Polysiphonia fibrillosa* are considered to be truly estuarine, for they were never found on the open coast. *Spongomorpha arcta, Porphyra leucosticta,* and *Ptilota serrata* appear to be coastal forms, since they were not found within the mouth of the river.

Discussion

The variety and abundance of rock are major factors restricting growth and distribution of algae in the Merri-

mack River Estuary. The breakwater at stations 1 and 2 provided maximum stability and surface area for the growth of seaweeds, and the highest species numbers and biomass of algae were evident at these two sites. The reduced species and biomass (based on a qualitative assessment of all species) upstream of station 5 can be attributed, at least in part, to unsuitable substrate. Most rocks upriver of this station were mud covered, and it is obvious that films of mud and silt will inhibit the attachment and growth of many algal species. In addition, small cobbles and pebbles, characteristic of upriver stations, are unsuitable as substrate for many larger plants, because of their instability. Only crustose algae such as *Hildenbrandia prototypus* and *Pseudendoclonium marinum* were found on such rocks. *Vaucheria* sp., *Enteromorpha* spp., and various blue-green algae were the only forms collected on the muddy surfaces stabilized by the roots of *Spartina alterniflora* and *Spartina patens.* The *Spartina* spp. play an important role in the formation of substrate suitable for algal colonization.

In contrast, the rocky substrate at stations 1 and 2 was not suitable for attachment and colonization of estuarine vascular plants, and progressive increases in numbers of estuarine vascular plants were observed in relation to a decrease in the amount of rocky substrate upstream. Therefore, an increase in biomass and species numbers of vascular plants upriver can be attributed to suitable substrate, including small rocks and fibrous peat. Maximum species numbers occurred at stations 5, 7 and 11. Beyond station 11 the reduction in species number (but not biomass) probably resulted more from sub-optimal hydrographic factors than from suitability of substrate. *Scirpus validus, Scirpus maritimus, Acorus calamus,* and *Zizania aquatica* accounted for nearly all the plant biomass at many of the latter stations.

Spatial and temporal variations of hydrographic factors in the Merrimack River Estuary, particularly the low upstream salinities, restrict the longitudinal distribution of

many species (Mathieson and Burns, 1971; Mathieson, *et al.*, in press). Algal species having limited tolerances to temperature and salinity changes would not be expected to migrate upstream for any distance. As suggested earlier, *Spongomorpha arcta, Porphyra leucosticta,* and *Ptilota serrata* have a distinctly coastal distribution, and they did not extend inland of station 1. Other species exhibited gradations of tolerances to temperature and salinity fluctuations within the estuary. The most tolerant ones exhibited the widest distributions (e.g., *Enteromorpha erecta* and *Vaucheria* sp.), while the less tolerant ones had limited estuarine distributions (e.g., *Elachista fucicola* and *Petalonia fascia*). For the algae the most conspicuous reduction in species diversity occurred between stations 5 and 6; it was probably caused by the greater fluctuations of temperature and salinity and the limited amount of solid substrate.

Pollution is an important limiting factor in algal distribution and abundance (North, *et al.*, 1964; Patrick, 1964). A comparison of the species composition of seaweeds from the Merrimack River Estuary with that of the Hampton-Seabrook Estuary (Mathieson and Fralick, 1972) and the Great Bay Estuary Systems (Mathieson, Reynolds, and Hehre, in press) of New Hampshire indicates a paucity of total species and species numbers per station in the Merrimack. A total of 118 taxa of seaweeds was collected from the Hampton-Seabrook Estuary and the adjacent open coast, while over 150 species were found within the vicinity of the Great Bay Estuary System. The low algal species diversity (only 31 taxa) from the Merrimack River Estuary is probably also due to the extreme domestic and industrial pollution of this interstate river. Jerome *et al.* (1965) and Miller, *et al.* (1971) indicate that the Merrimack is one of the most polluted rivers in New England.

The concept of species diversity has been applied extensively in evaluating eutrophication of freshwater habitats. In general, a decrease in species diversity is a typical response to an increase in either domestic and/or industrial

pollution (Patrick, 1964). Under polluted conditions, a few tolerant species tend to dominate in large numbers and high biomass. The abundance of many Ulotrichalean green algae such as, *Enteromorpha* spp., *Ulva lactuca*, and *Monostroma* sp. typifies a polluted estuarine habitat (Cotton, 1910; Fritsch, 1935). These species are not only tolerant of extremes in pollution, but of gross fluctuations in hydrographic factors.

In summary the paucity of the algal flora may be attributed to the following: (1) limited solid substrate for benthic species; (2) probably to the high degree of pollution of the Merrimack River Estuary. The abundance of certain algae definitely seems to be related to the pollution factor.

The authors wish to thank Dr. Donald Normandeau, of Normandeau Associates, who provided a boat, outboard motor and other support to complete the investigation. Dr. B. Miller, formerly with the same company, is also acknowledged for his assistance with the collection of specimens. We also express our appreciation to Dr. A. Hodgdon for his identification of several vascular plants.

REFERENCES CITED

COTTON, A. D. 1910. On the growth of *Ulva latissima* in water polluted by sewage. Bull. Misc. Inform. Roy Bot. Gard. Kew, pp. 15-19.

FERNALD, M. L. 1960. Gray's Manual of Botany, 8th Edition, American Book Company, New York, 1632 pp.

FRITSCH, F. E. 1935. The structure and reproduction of the algae. Vol. I, Cambridge Univ. Press, 791 pp.

JEROME, W. C., A. P. CHESMORE, C. O. ANDERSON, JR., and F. GRICE, 1965. A study of the marine resources of the Merrimack River Estuary. Monograph Ser. No. 1, Div. of Mar. Fish., Dept. of Natl. Res., The Comm. of Mass., 90 pp.

MATHIESON, A. C. and R. L. BURNS. 1971. Ecological studies of economic red algae I. Photosynthesis and respiration of *Chondrus crispus* Stackhouse and *Gigartina stellata* (Stackhouse) Batters. J. Exp. Mar. Biol. Ecol. **7**: 197-206.

————————, and R. A. FRALICK. 1972. Investigations of New England marine algae. V. The algal vegetation of the Hampton-

Seabrook Estuary and the open coast near Hampton, New Hampshire. Rhodora **74**: 406-435.

————————, N. B. REYNOLDS and E. HEHRE. Ibid. II. Distribution of benthonic marine algae in the Great Bay Estuary System. Nova Hedwigia (in press).

MILLER, B., D. NORMANDEAU, G. PIEHLER, P. HALL, A. MATHIESON, R. FRALICK, D. TURGEON, P. MAHONEY and W. OWEN. 1971. Ecological study Merrimack River Estuary — Massachusetts, Presented to the U. S. Army, Corps of Engineers by Normandeau Associates, Inc. and Vast Inc., 342 pp.

NORTH, W. J., K. A. CLENDENNING, L. G. JONES, J. B. LACKEY, D. L. LEIGHTON, M. NEUSHUL, M. C. SARGEANT and H. L. SCOTTEN, 1964. Investigation of the effects of discharged wastes on kelp, State Water Quality Control Bd., Publ. 26, 124 pp.

PARKE, M. and P. S. DIXON. 1968. Check-list of marine algae — second revision. J. Mar. Biol. Assoc., U.K. **48**: 783-832.

PATRICK, R. 1964. A discussion of natural and abnormal diatom communities. In D. F. JACKSON (Ed.) Algae & Man, Plenum Press, pp. 185-204.

DEPARTMENT OF BOTANY AND THE
JACKSON ESTUARINE LABORATORY OF THE
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03284

SOME MORPHOLOGICAL AIDS IN DISTINGUISHING NUPHAR MICROPHYLLUM FROM SIMILAR AQUATICS

JOHONET C. WICKS

This study is an outgrowth of my recent discovery that a specimen of *Nuphar microphyllum* (Pers.) Fern in the University of New Hampshire Herbarium had been erroneously labelled *Nymphoides cordata* (Ell.) Fern because of the apparently identical macroscopic appearance of the small floating leaves despite the presence of filmy submersed foliage characteristic of *Nuphar*. This specimen, collected in Adams Pond in Pittsfield, N. H., constitutes a first record for Merrimack County and, more significantly, represents the most southern collection point in the state known at the present time. *Nuphar microphyllum* occurs generally in Maine and in Massachusetts, and to a more limited extent in Vermont and Connecticut, but has been reported in New Hampshire only in Coös and Carroll counties according to F. C. Seymour (1969). Research at the Gray Herbarium yielded two specimens from the same locality in Hanover in Grafton County in the early 1900's; and, more recently, C. Barre Hellquist has added another Grafton County station at Lily Pond in Livermore. Perhaps New Hampshire ponds have not been as thoroughly botanized as have those in Maine, Vermont and Massachusetts. Future investigation may disclose the fact that *N. microphyllum* occurs more frequently, if not much more abundantly, in the state than has heretofore been suspected.

The pH and alkalinity of ponds sometimes affect the distribution of species. Professor Hellquist kindly furnished readings taken by him at some ponds where *Nuphar microphyllum* occurs in Maine, Vermont and in Coös, Carroll and Grafton counties in New Hampshire. In New Hampshire the pH ranges from 6.0 to 6.7 whereas in Maine and Vermont, pH values are generally in the 7 range up to 7.9. The alkalinity readings for New Hampshire run from 2.5

ppm to 9.0 ppm of carbonates and bicarbonates but are considerably higher, 9.0 ppm to 60.0 ppm, in Vermont and Maine. The above limited data seem to indicate that *N. microphyllum* is adapted to a pH close to neutral and tolerates a wide range of alkalinity. Perhaps the more acidic waters of New Hampshire ponds and the lower concentration of carbonates and bicarbonates do not favor growth of this species.

Seymour lists not only Coös and Carroll counties but also Cheshire County for *Nuphar* × *rubrodiscum* Morong, a fertile hybrid between *N. variegatum* Engelm. and *N. microphyllum*. In the light of the Grafton County records of *N. microphyllum* cited above and the Merrimack County record reported in this paper, it would seem plausible that hybridization could have occurred in these counties although no hybrids have as yet been reported. Examination of the Cheshire County specimens, one each in the Gray and New England Botanical Club herbaria from Gilmore Pond in Jaffrey in 1897, revealed them to truly be *N.* × *rubrodiscum* according to both the author and A. R. Hodgdon. Although it has not yet been reported, one would expect to find *N. microphyllum*, one of the parents, in the county and possibly in the same pond. When and if it is discovered, it will constitute the southernmost record for the state. However, as the two Jaffrey specimens were collected prior to 1900, it is conceivable that the species could have since disappeared.

It is sometimes difficult to differentiate the hybrid from either parent as the range of parental characteristics is a broad one in regard to such morphological features as the size of the leaf, the diameter of the petiole and the size of the flower. Figure 1A, a comparison of the minimum and maximum lengths of the floating leaves in the three species as indicated in current manual descriptions, shows a considerable overlap which makes identification troublesome, if not impossible, on the basis of leaf size alone. It is then advisable to examine the diameter of the petiole as shown in figure 1B. The petioles of *Nuphar microphyllum* leaves

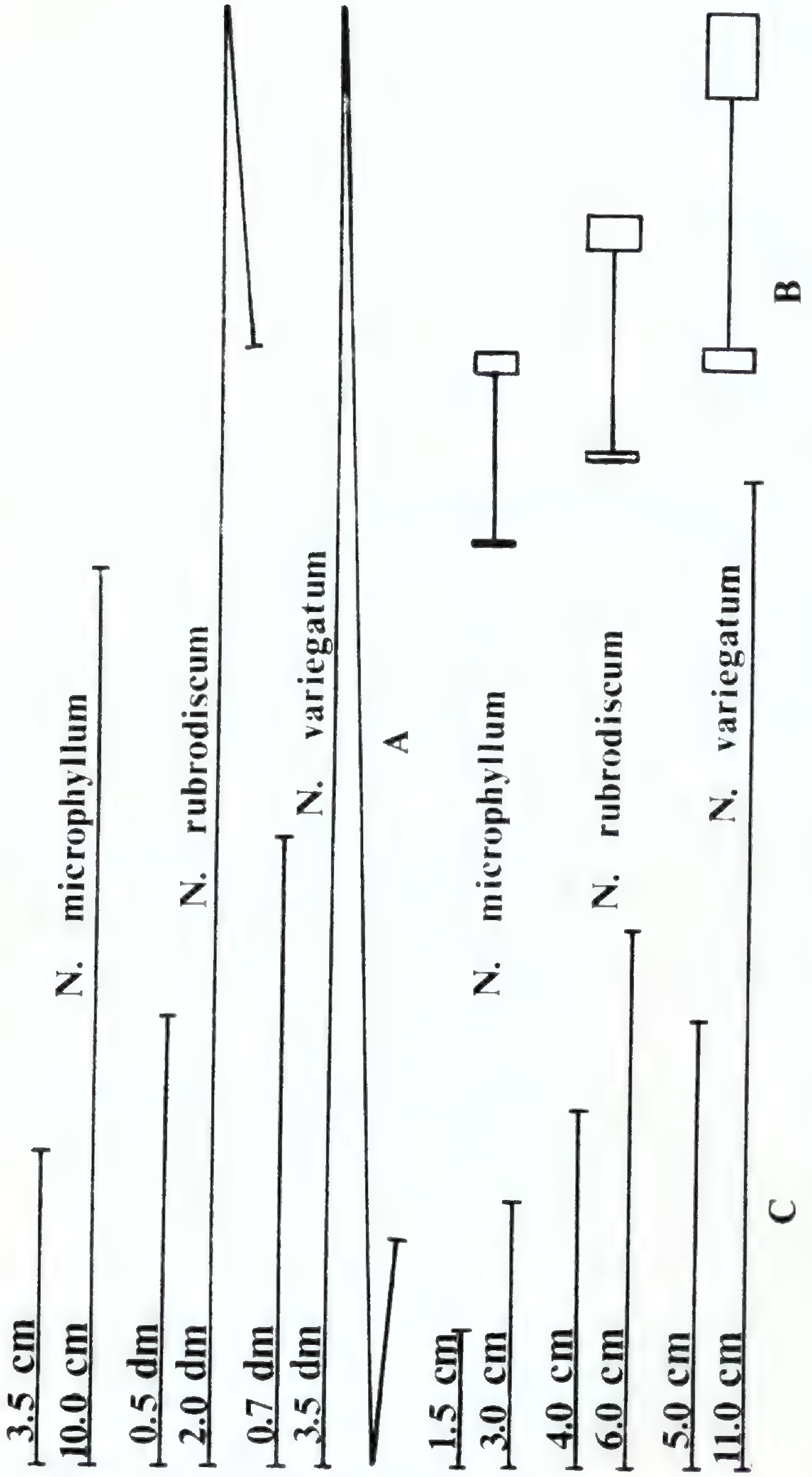


Figure 1: A. Comparative minimum and maximum lengths of the floating leaves of *Nuphar*. B. Comparative diameters of petioles of *Nuphar*. C. Comparative minimum and maximum widths of flowers of *Nuphar*. All dimensions are actual size.

are markedly filiform. Careful measurement of petioles of all three species in the New England Botanical Club Herbarium indicated a significant overlapping of petiole diameters. A specimen with a leaf and petiole within the size range of both *N. microphyllum* and *N.* × *rubrodiscum* would still be puzzling. The final recourse then is to the flower or fruit. Figure 1C illustrates the comparative widths of the flowers of the three species when laid open, following dimensions given in *Gray's Manual.* For the first time, there is no overlap between *N. microphyllum* and *N.* × *rubrodiscum.* Furthermore, the petals and stamens of the flower of *N. microphyllum* are promptly deciduous whereas, in the other two species, they persist at the base of the young fruit. I examined the specimens of all three species in the New England Botanical Club Herbarium and, with the approval of A. R. Hodgdon, reannotated four of them. Two were transferred from *N. microphyllum* to *N.* × *rubrodiscum* and two were changed from *N. variegatum,* one each to *N. microphyllum* and *N.* × *rubrodiscum.*

The genus *Nuphar* is characterized by dimorphic leaves: filmy, undulate submersed leaves and the well known firmer floating leaves. In his descriptions of the three species of *Nuphar,* Fernald (1950) mentions only *N. microphyllum* as possessing filmy submersed leaves. Fassett (1966) fails to note the presence of this foliage in any of the three species. It is of interest that Otto Brunfels in 1530 in his illustrated herbal, *Herbarium Vivae Eicones,* included a drawing of *Nuphar luteum,* a European species, depicting both types of foliage.

The thin submersed leaves tend to disappear in *Nuphar variegatum* as the plant grows larger and older whereas they generally seem to persist in *N. microphyllum* (figure 2A) and to a lesser degree in the hybrid, *N.* × *rubrodiscum.* Perhaps their persistence in *N. microphyllum* accounts for their being mentioned by Fernald. These observations are based on a study of the New England Botanical Club specimens: of 23 specimens of *N. microphyllum* with

Figure 2: A. *Nuphar microphyllum* habit × ¼. B, C, D. *Nuphar variegatum*, seedling stages × ¼.

basal parts, 19 have filmy submersed foliage; of 11 specimens of *N.* × *rubrodiscum*, 7 have filmy leaves; of eight folders of *N. variegatum* containing a great many specimens, only 3 sheets have this foliage.

The seedlings of all three species have membranaceous foliage with filiform petioles (figure 2B, C, D). It would require careful observation to distinguish between the three species in the seedling stage. Determination of species could possibly be made on the basis of seedling size if the seeds of each species are of different sizes which has yet to be established. The size of seedlings, however, could be confounded by variability in age. One way to solve this problem would be to germinate seeds of each species and to observe differences in size of seedlings with age as a control factor. However this procedure, while of value under controlled conditions, would not shed much light on relative age and size in the field. Perhaps the location of a seedling could indicate its species although in mixed colonies this criterion would be inadequate. While examining specimens of *Nymphoides cordata* in the New England Botanical Club Herbarium, I found a sheet of *Nuphar* seedlings, possibly those of *N. microphyllum*, labelled as seedlings of *Nymphoides*.

Nuphar microphyllum, as shown in figure 2A, appears to be a composite of a *Nuphar* seedling with attached floating leaves of *Nymphoides cordata*. The close resemblance between the floating leaves of *N. microphyllum* and those of *Nymphoides* in regard to both size and shape is startling and can lead to a confusion of the two species especially when underwater foliage is not present and when *Nymphoides* lacks the characteristic cluster of thick roots on the petiole just below the surface of the water. Figure 3 shows the similarity in shape between the floating leaves of the two species as well as the variability within each species. These are reduced leaf tracings from herbarium specimens. The shape and width of the sinus show remarkable variation. Some specimens of *N. microphyllum* exhibit a wide V-shaped sinus while others have a very

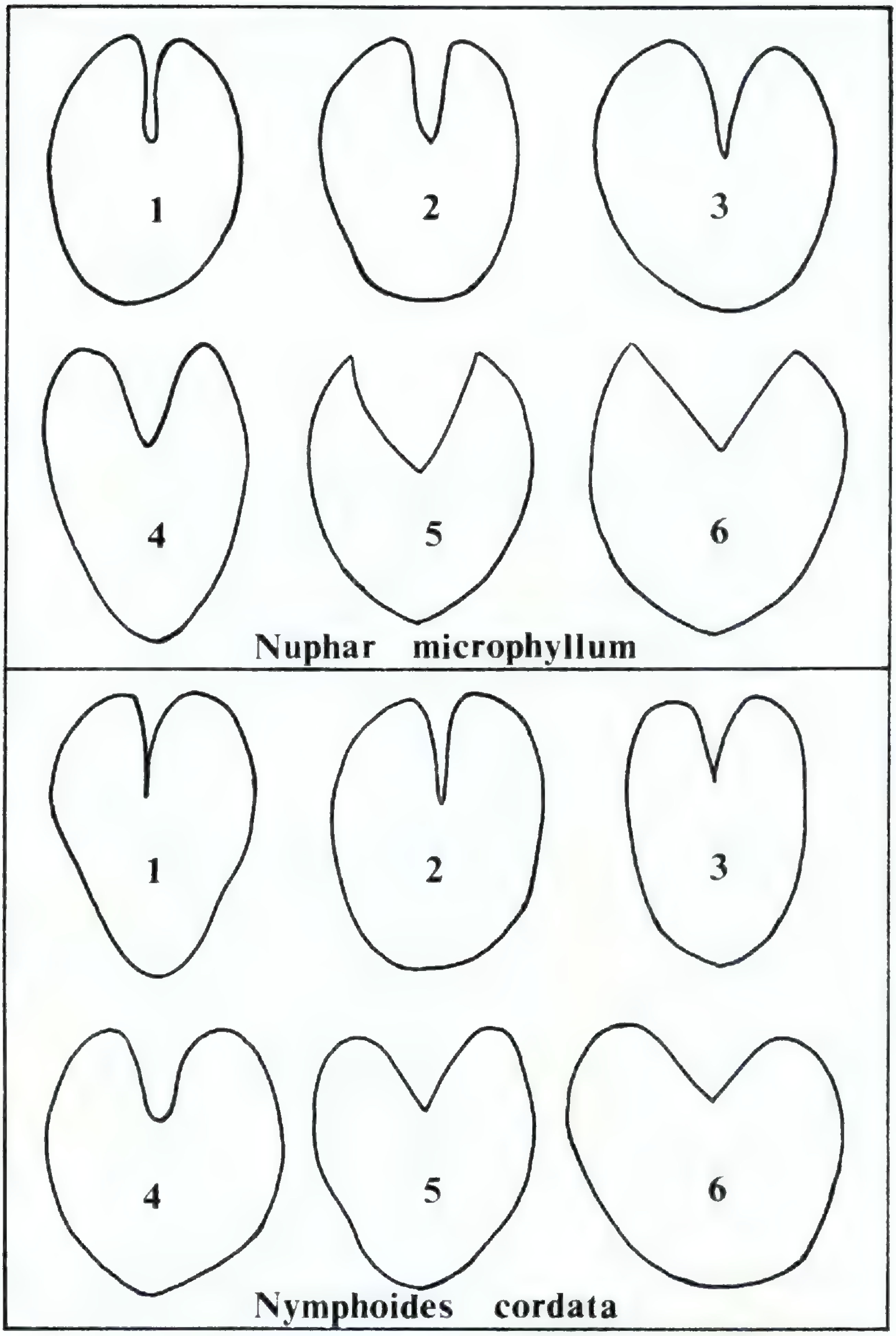


Figure 3. Similarity and variability in leaf shape of the floating leaves of *Nuphar microphyllum* and *Nymphoides cordata*.

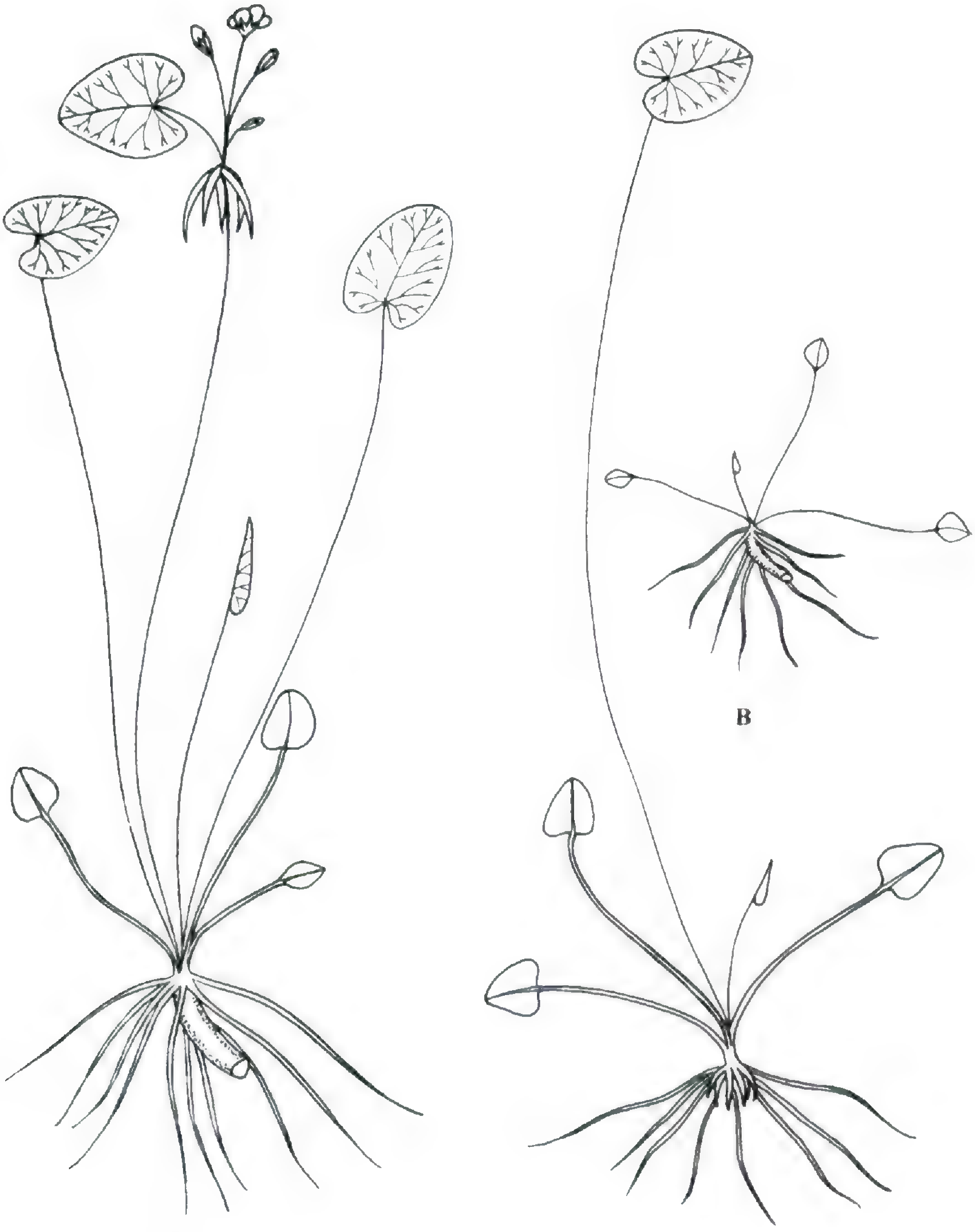


Figure 4: A. *Nymphoides cordata*, habit × ½. B. Seedling × ½. C. Young plant × ½.

narrow sinus with almost parallel sides. The shape of the sinus of the floating leaves is similar to that of the submersed foliage on the same plant.

Nymphoides cordata also possesses dimorphic leaves. In addition to the floating cordate leaves, the plant has smaller rhombic submersed leaves characteristic of the seedling stage and of the young plant (figure 4A). The illustration of the seedling (figure 4B) depicts the generation of a new plant from the rhizome whereas the drawing of the young plant (figure 4C) seems to indicate that a new individual can also arise by vegetative propagation from the detachment, submergence and subsequent rooting of a leaf and petiole with its group of thickened roots. The underwater leaves are absent in many, but not all, of the specimens studied. Their frequent absence in more mature plants may account for the fact that neither Fernald nor Fassett mentions these submersed leaves in their descriptions of the species. Drawings of *Nymphoides* in both Fassett's book and in that of N. Hotchkiss (1967) have no basal parts, only the floating leaf and the short, spur-like thickened cluster of roots attached to the petiole at which point the flowers arise.

In conclusion, it is sometimes difficult to distinguish *Nuphar microphyllum* from other similar aquatic plants. When the entire plant including the floating leaves, filmy submersed leaves, flower or fruit are present, it cannot be mistaken for *Nymphoides cordata*; if only the floating leaves and submersed foliage are present, it could be confused with *N.* × *rubrodiscum*; when only the floating leaves are evident, it could be taken for either *N.* × *rubrodiscum* or *Nymphoides*. This confusion points out the desirability of collecting as complete specimens as possible.

The illustrations were prepared by the author from specimens in the University of New Hampshire Herbarium (NHA) from localities in Maine and New Hampshire.

I greatly appreciate the privilege of using the New England Botanical Club and Gray herbaria without which this study would have been impossible.

LITERATURE CITED

FASSETT, N. C. 1966. *A Manual of Aquatic Plants.* Madison: The University of Wisconsin Press.

FERNALD, M. L. 1950. *Gray's Manual of Botany,* Eighth Edition. New York: American Book Company.

HOTCHKISS, N. 1967. *Underwater and Floating-Leaved Plants of the United States and Canada.* Washington, D.C.: Resource Publication 44.

PEASE, A. S. 1964. *A Flora of Northern New Hampshire.* Cambridge: New England Botanical Club, Inc.

SEYMOUR, F. C. 1969. *The Flora of New England.* Rutland: The Charles E. Tuttle Company.

DEPARTMENT OF BOTANY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, N.H. 03824

A RE-EVALUATION OF POTAMOGETON FIBRILLOSUS FERN. (POTAMOGETONACEAE)[1]

ROBERT R. HAYNES AND JAMES L. REVEAL

In 1932, Fernald proposed *Potamogeton fibrillosus* based on specimens collected in Wyoming, Idaho, Oregon and Washington. He noted that the new species closely resembled *P. foliosus* Raf. in its foliage, peduncles and small dorsally keeled fruits. It was said to differ from *P. foliosus* by its stipules which disintegrate into "rope-like" fibers and are thus open or convolute, and by having fruits with a less developed keel and more nearly median beak. In his closing comment on the species, Fernald (1932; p. 52) stated his reservations in assigning specific rank to this new entity: "The plant will doubtless be found to have a broader range, when it may prove to be a marked geographic variety of the wide-spread *P. foliosus.*"

Evidence from our field work (Haynes as part of his doctoral studies and Reveal as part of his review of *Potamogeton* for the *Intermountain Flora*), from examination of most of the cited specimens noted by Fernald (1932) and from a review of more recently gathered material from other localities substantiates his closing remarks. Several collections, especially from Yellowstone National Park of Wyoming and from southeastern Oregon, are distinct from *P. foliosus*. In general, these specimens differ from *P. foliosus* not only in having the stipules disintegrating into fibres and fruits with poorly developed keels, but also in having cylindric, interrupted inflorescences and leaves with basal glands — the last two characters not mentioned by Fernald, but present even on the holotype.

Other collections from the Yellowstone region are not so distinct. One such collection (*Haynes* 3849) has fruits, including the keel, which are identical with those of *Potamo-*

[1]Contribution from the Botany Department, The Ohio State University (Paper No. 828). The work of the junior author was supported by National Science Foundation Grant GB-22645.

geton foliosus, but the inflorescence is capitate and the stipules only rarely disintegrate into fibers. However, basal glands are present. Flowering specimens from Albany Co., Wyoming, made by C. L. Porter (*3473*) are similar to *P. fibrillosus* in having basal glands and short, clavate peduncles. However, in this collection, the stipules only rarely disintegrate into fibers. Flowering specimens obtained by Maguire (*21578*) in northern Utah commonly produce fibers when the stipules decay, but basal glands are rarely found. Unpublished data of Haynes indicate, for other species of *Potamogeton*, that the degree of connation of the stipules is not a reliable taxonomic character and can not be used successfully in distinguishing species.

Hitchcock (1969) regarded *Potamogeton fibrillosus* as a distinct species, but conceded its close relationship with *P. foliosus*. Porter (1963) reduced *P. fibrillosus* to synonymy, regarding it only as a local form of *P. foliosus* produced by the rather warm-water conditions of "geyser formations and hot springs" in the Yellowstone area. Porter stated (1963; p. 9) "The warm water hastens disintegration of the sheaths by bacterial action." This is not the case, however, in northern Utah or southeastern Oregon. Here the water is cool, usually fresh (although slow-moving or infrequently standing), and the stipules still break down. As we know of sites where both entities can be found in close proximity, and at the same degree of development, it seems unlikely that mere bacterial activity (or some other type of mechanical breakdown) could account for the fibrous stipules. Nevertheless, because this entity, in most situations, can be distinguished quite easily from *P. foliosus*, we think it should be taxonomically recognized. However, since many intermediate forms can be detected, we can not justify the specific rank and therefore propose: **Potamogeton foliosus** Raf. var. **fibrillosus** (Fern.) Haynes & Reveal, stat. & comb. nov., based on *P. fibrillosus* Fern., Mem. Amer. Acad. Arts 17:51. 1932. — In warm spring, margin of Harney Valley, at "P" Ranch, Harney Co., Oregon, 22 Jun 1901, *Cusick* 2598. Holotype, GH! Isotypes, F, K, MO, ORE, US!

From var. *foliosus*, the var. *fibrillosus* may be distinguished by its poorly developed keel, cylindric and interrupted inflorescence, fibrous stipules and basal glands present at the base of most leaves.

Distribution. — In waters, often warm, of shallow lakes, springs, streams and rivers, from southwestern Washington southward through southeastern Oregon, hence eastward to southeastern Wyoming. Fruiting from mid-June to mid-September.

Representative Specimens. — **Oregon:** HARNEY CO.: warm springs near Burns, 17 May 1927, *Henderson* 8867 (GH); in irrigating ditch at Frenchglen, 15 Jul 1927, *Thompson* 12068 (NY, WTU). MALHEUR CO.: Otis Creek, 20 Jun 1896, *Leiberg* 2340 (GH, US). **Utah:** CACHE CO.: slow stream in meadow, 3 mi ne of Logan, 21 May 1939, *Maguire* 16685 (MO, NY, UTC); slow-moving stream in meadow, 2 mi nw of Logan, 23 Jun 1942, *Maguire* 21578 (F, GH, MO, NY, US, UTC). **Washington:** PIERCE CO.: In outlet to Lake Spanaway, near Tacoma, 4 Aug 1933, *Thompson* 9657 (GH, WTU). UNKNOWN LOCATION: Washington Territory, 1883, *Brandegee* 1127 (GH). **Wyoming:** ALBANY CO.: N. Fork of Poole Creek, 5 Aug 1944, *C. L. Porter* 3474 (NY, RM, US). YELLOWSTONE NATIONAL PARK [or Park Co.]: Firehole River, 24 Jul 1906, *Jepson* 2540 (GH); Midway Geyser Basin, Firehole River, in warm, swift-flowing water, 30 Aug 1971, *Haynes* 3850 (GH, MICH, MO, NY, OS); Upper Geyser Basin, 1 Sep 1878, *Richardson s.n.* (GH); Upper Nez Perce Creek, in swift flowing water, 30 Aug 1971, *Haynes* 3849 (MICH, OS).

LITERATURE CITED

FERNALD, M. L. 1932. The linear-leaved North American species of Potamogeton, section Axillares. Mem. Amer. Acad. Arts **17**: 1-183.

HITCHCOCK, C. L. 1969. "Potamogetonaceae." *In:* Hitchcock, C. L. et al. "Vascular plants of the Pacific Northwest." Univ. Wash. Publ. Biol. **17**(1): 158-175.

PORTER, C. L. 1963. "13. Najadaceae." *In:* A flora of Wyoming. Part II. Wyoming Agric. Exp. Sta. Bull. **404**: 6-12.

COLLEGE OF BIOLOGICAL SCIENCES
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210
and
DEPARTMENT OF BOTANY
UNIVERSITY OF MARYLAND
COLLEGE PARK, MARYLAND 20742

THE AUDOUINELLA COMPLEX (RHODOPHYTA) IN THE WESTERN SARGASSO SEA

William J. Woelkerling

The macroscopic vegetation of the western Sargasso Sea is known mainly from four accounts (Harvey 1852, Boergesen 1914, Winge 1923, Parr 1939) which deal almost exclusively with the genus *Sargassum*. Except for two recent papers (Carpenter 1970, Woelkerling 1972b), only isolated records of other macroscopic or epibiotic algae from this region have appeared in the literature (Collins 1917, Conover and Sieburth 1964, Farlow 1914, Hentschell 1921, Prat 1935). These reports leave a number of points to be clarified including identification to species in most cases. To date only one reference (Conover and Sieburth 1964, p. 150) to an unidentified audouinelloid alga in this region has been published.

The present study was initiated after an analysis of several samples of *Sargassum* from the western Sargasso Sea revealed the presence of numerous epiphytic audouinelloid plants. This paper incorporates data from six cruises to the Sargasso Sea by vessels of the Woods Hole Oceanographic Institution and includes a morphotaxonomic account of the audouinelloid algae found to date.

MATERIALS AND METHODS

Samples of *Sargassum* were gathered with the aid of a long-handled dip net, immediately preserved in 1:10 formalin in sea water, and brought back to shore for subsequent study. Vouchers of all collections have been prepared in the form of permanent microscopic slides (Woelkerling 1970) or as liquid preserved material in 10:1 70% ethanol in glycerine. Herbarium numbers designated WJW are those in the author's personal collections; other herbarium abbreviations follow Lanjouw and Stafleu (1964). Line

drawings have been made with the aid of a Leitz drawing head microscope attachment.

In all cases morphological data is based on plants found in the Sargasso Sea and represents, wherever possible, the results of analyses of populations rather than of isolated plants.

The taxonomic proposals of Woelkerling (1971) have been adopted during this study, including the use of older generic names in cases of possible synonomy in order to avoid making new and unnecessary nomenclatural combinations. In species descriptions, the designation L/D refers to the ratio of cell length to cell diameter.

GENERAL OBSERVATIONS

Of the six species found to date, *Colaconema infestans* (Howe et Hoyt) comb. nov. occurs in nearly all collections, and *Audouinella daviesii* (Dillwyn) Woelk., *A. hallandica* (Kylin) comb. nov., and *A. thuretii* (Bornet) Woelk. appear fairly frequently as well. *Audouinella microscopica* (Naegeli) Woelk. and *Calaconema scundata* (Lyngbye) comb. nov., in contrast, have been encountered on only several occasions.

Monosporangia occur in all species and tetrasporangia also have been found in *A. thuretii*; sex organs, however, are apparently wanting. The formation of reproductive bodies is in noteworthy contrast to the situation in *Sargassum fluitans* (Boergesen) Boergesen and *S. natans* (L) J. Meyen, the two most conspicuous algae of the Sargasso Sea, which apparently never become fertile (see, however, Parr 1939, p. 49).

The audouinelloid algae probably represent a permanent component of the Sargasso Sea flora rather than being a temporary invading element (see Woelkerling 1972b) since they frequently epiphytize *Sargassum fluitans* and *S. natans*, which are apparently endemic to this region. However, all species found to date in the Sargasso Sea are also reported from Bermuda, the Caribbean, or the North

American mainland (Boergeson 1915, 1924; Collins and Hervey 1917; Taylor 1960). It is likely that these land masses act as distribution centers; in fact several collections examined during the present study have been attached to hosts (e.g. the grass *Spartina*) from inshore areas.

In general, the morphotaxonomic conclusions reached by Woelkerling (1971) are supported by this investigation. Differences between species in which the prostrate system is dominant and those in which the erect system is dominant have become more apparent to the author as a result of the current investigation, and it appears that at least two distinct habits occur among species with multicllular prostrate systems: 1) a stoloniferous habit in which the prostrate filaments are more or less widely creeping and give rise to erect filaments at irregular intervals, and 2) a more or less caespitose habit in which the prostrate filaments are generally pseudoparenchymatously united into a disc or funiform mass which, in turn, gives rise to a number of erect filaments in close proximity to one another. In stoloniferous forms, the prostrate system usually predominates while in caespitose forms, the erect system usually predominates.

KEY TO SPECIES

1. Prostrate system normally absent; plants attached to substrate by a single basal cell which may rarely divide to form several accessory cells.
   2. Cells generally 5-10μ long, more or less barrel-shaped, commonly isodiametric or broader than long .... *Audouinella microscopica.*
   2. Cells generally 10-30μ long, more or less cylindrical, L/D usually more than 2 .... *Audouinella hallandica.*
1. Prostrate system present, filamentous or pseudoparenchymatous.
   3. Plants more or less stoloniform; prostrate system exceeding erect system in length; erect filaments rarely over 90μ long and commonly unbranched .... *Colaconema infestans.*
   3. Plants more or less caespitose; prostrate system not exceeding erect system in length; erect filaments commonly over 200μ long and branched.

4. Sporangia, in part at least, grouped in clusters of 3-8 in axils of lateral branches .... *Audouinella daviesii.*
4. Sporangia usually solitary or in pairs, not clustered in axils of lateral branches.
   5. Chromoplasts distinctly stellate; prostrate system at first a parenchyma-like group of cells; sporangia commonly on short (3-5 celled) lateral branches .... *Colaconema secundata.*
   5. Chromoplasts parietal lobate; prostrate system filamentous in young stages; sporangia situated on longer lateral branches .... *Audouinella thuretii.*

Audouinella daviesii (Naegeli) Woelkerling 1971: 28, Figs. 7, 22.

Acrochaetium daviesii (Dillwyn) Naegeli 1861: 405, Figs. 26-27. Boergesen 1924: 25, Fig. 8. 1827: 25, Fig. 15. Taylor 1960: 307.

Callithamnion daviesii (Dillwyn) Lyngbye 1819: 129 (only as to binomial).

Ceramium daviesii (Dillwyn) C. Agardh 1817: XXVII.

Chantransia daviesii (Dillwyn) Thuret in Le Jolis 1863: 106. Kylin 1907: 117, Fig. 27. Rosenvinge 1909: 104, Fig. 34.

Conferva daviesii Dillwyn 1809: 73, Suppl. pl. F.

Rhodochorton daviesii (Dillwyn) Drew 1928: 172. Nakamura 1944: 106, Fig. 5.

Trentepohlia daviesii (Dillwyn) Areschoug 1847: 338.

Note: Further synonomy is given by Woelkerling (1971, p. 28).

Plants epiphytic or epizoic, caespitose, up to 5 mm. tall; original spore non-persistent. Prostrate system consisting of branched filaments more or less forming a pseudoparenchymatous disc. Erect filaments freely and irregularly branched, commonly attenuate and ending in multicellular hair-like prolongations. Cells of main axes and laterals cylindrical, 8-15μ wide and (15-) 20-60μ long, L/D (1.75-) 2-4(-5); cells sometimes tapering to 2-8μ wide and 20-80μ long (L/D up to 35) near the apices; each cell containing a parietal lobate chromoplast with one pyrenoid.

Monosporangia ovoid, 8-13μ wide and 13-17(-22)μ long, in clusters of 3-8 on branched stalks or singly or in pairs on 1-2 celled stalks, situated on the lowermost cells of laterals or sometimes more scattered.

Other reproductive structures not observed in material examined.

Type Locality. — Bantry Bay, Ireland (Hutchens); locality for H. Davies collection not given by Dillwyn (1809).

Holotype. — NMW.

Distribution. — Nearly cosmopolitan.

Hosts. — Hydroids, *Sargassum*, and *Spartina* (Angiospermae) fragment in Sargasso Sea; a wide variety of algae, marine angiosperms, and invertebrates elsewhere.

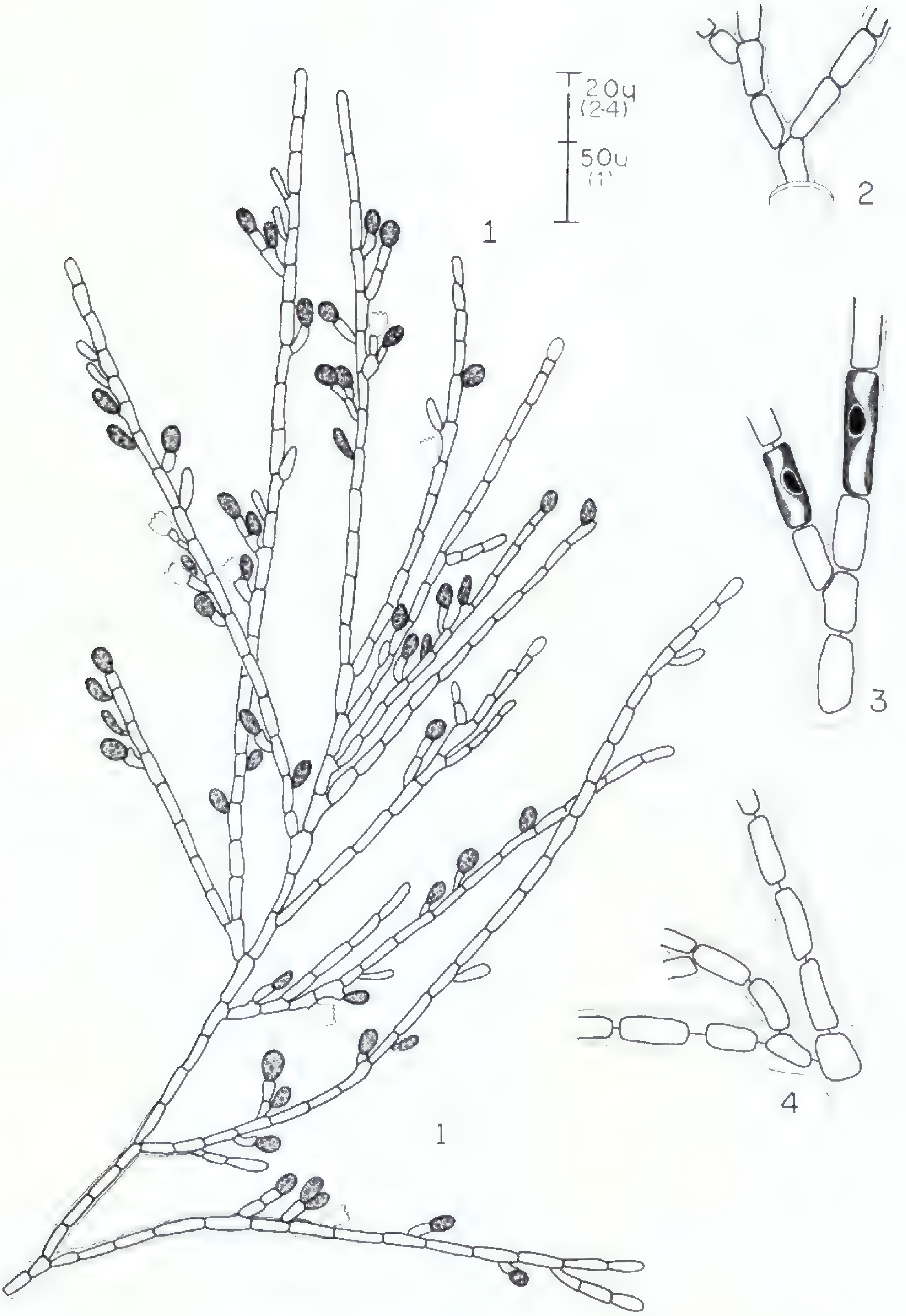
Specimens examined. — **Sargasso Sea:** 26° 57′N-72° 58′W, 26.iv. 1970, *Moore* (WJW 2648); 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2429); 31°N-69° 29′W, 3.iii.1970, *Volkman* (WJW 2380), (WJW 2364); 32° 09′N-64° 58′W, 16.V.1970, *Woelkerling* (WJW 2667); 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2396), (WJW 2409); 37°N-70°W, 12.v. 1970, *Woelkerling* (WJW 2621); 38° 22′N-70°58′W, 12.x.1970, *Volkmann* (WJW 2888); 39° 07′N-70° 35′W, 16.viii.1970, *Moore* (WJW 2930). **Ireland:** Bantry Bay, prior to 1809, *Hutchins* (NMW, Dillwyn Collection, type).

Populations of *A. daviesii* examined during this study agree in all essentials with the type material and with plants described in the accounts of Rosenvinge (1909) and Woelkerling (1971). Multicellular hair-like prolongations with poorly developed plastids often devoid of pyrenoids occur very frequently in Sargasso Sea plants.

Clustered monosporangia are common in most collections (2621 represents the only exception), but tetrasporangial and sexual individuals (see Woelkerling 1971 for accounts of these stages) have not been encountered.

Audouinella hallandica (Kylin) comb. nov. Figs. 1-4.

Acrochaetium hallandicum (Kylin) Hamel 1927: 20, Figs. 19-21; 1928: 114, Figs. 19-21.



Figs. 1-4. *Audouinella hallandica* (Kylin) comb. nov. Fig. 1. Monosporangial plant. Figs. 2-4. Variation in shape of basal cell. Note chromoplasts (Fig. 3).

Chantransia hallandica Kylin 1906: 123, Fig. 8. Rosenvinge 1909: 93, Figs. 21-23.
Chromastrum hallandicum (Kylin) Papenfuss 1945: 321.
Kylinia hallandica (Kylin) Kylin 1944: 13, 15, Fig. 7.
Rhodochorton hallandicum (Kylin) Rosenvinge 1935: 7.
Acrochaetium dufourii (Collins) Boergesen 1915: 19. Hoyt 1920: 470, Fig. 26. Collins *In* Collins, Holden, and Setchell 1909: 1594 (Nom. Nud.). Collins and Hervey 1917: 96. Taylor 1960: 305.
Chantransia dufourii Collins 1911: 187.
Kylinia dufourii (Collins) Kylin 1944: 13.
Acrochaetium sargassi Boergeson 1915: 17, Figs. 7-10. Taylor 1925: 129. 1928: 134, pl. 22, Figs. 1-5. 1960: 306.
Chantransia sargassi (Boergeson) DeToni 1924: 45.
Kylinia sargassi (Boergesen) Kylin 1944: 13.

Plants epiphytic, up to 1 mm. tall, original spore persisting as a unicellular base the same size or somewhat larger than other cells and giving rise to 1-2 main axes. Erect filaments moderately and irregularly branched, occasionally tapering towards the tips; unicellular hairs not observed. Cells cylindrical, 4-7μ wide and 10-30μ long (L/D 2-5), each containing a parietal lobate chromoplast and one pyrenoid.

Monosporangia ovoid, 6-8μ wide and 8-11 (-15)μ long, singly or in pairs, sessile or stalked, scattered over the erect filaments adaxially and occasionally abaxially as well.

Other reproductive structures not observed.

Type Locality. — Hogardsgrund, Halland, Sweden.

Holotype. — Apparently not designated by Kylin. Material on three prepared slides in LD dated 13.vii.1904 has been chosen as lectotype.

Distribution. — Sargasso Sea; Europe, Atlantic Coast of North America.

Hosts. — *Sargassum natans, Sargassum* sp., and hydroids in Sargasso Sea; elsewhere on a variety of algae.

Specimens examined. — **Sargasso Sea:** 31°N-69° 29′W, 3.iii.1970, *Volkmann* (WJW 2385); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2210), 7.iii.1970, *Volkmann* (WJW 2401); 36°N-70° 36′W, 9.xii.1970, *Moore* (WJW 2944). **Sweden:** Hogardsgrund, Halland Coast, 13.vi.1904, *Kylin* (LD, lectotype). **United States:** Beaufort, North Carolina, 13.vii.1908, *Hoyt* (FH, Co-type of *Acrochaetium dufourii* Collins). **Virgin Islands:** St. Thomas harbour, 26.xii.1905, *Boergesen* (C, type of *Acrochaetium sargassi* Boergesen).

Specimens of *Audouinella hallandica* from the Sargasso Sea compare favorably with lectotype material from the Halland Coast of Sweden. Neither the lectotype nor any Sargasso Sea collections contain sexual plants; these, however, have been described from Denmark (Rosenvinge 1909, p. 93, Figs. 21-22), France (Hamel 1927, p. 20, Figs. 19-20), and the Virgin Islands (Boergesen 1915, p. 17, Figs. 7-10 — as *Acrochaetium sargassi*).

The taxa originally described as *Acrochaetium sargassi* Boergesen and *Chantransia dufourii* Collins are here considered conspecific with *Audouinella hallandica* after critical comparisons of type collection material. Plants in all three type collections show virtually the same range of cell and spore dimensions and also show good morphological agreement in other respects. Taylor (1960, p. 302) has attempted to distinguish *Acrochaetium sargassi* from *A. dufourii* on the basis of slight differences in cell width and basal cell size, but neither of these characters has proven reliable as a result of this study. Boergesen (1915, p. 19) also expressed some doubt about the taxonomic differences between the two taxa.

The morphotaxonomic relationships of *Audouinella hallandica* to other audouinelloid algae appear to be very complex and involve at least 15 other taxa (including *Chantransia parvula*, regarded by Rosenvinge (1909) and Hamel (1927) as conspecific with *Audouinella hallandica*). Pending critical studies of the types and other collections of all taxa involved, the relationships of *A. hallandica* to other species in the complex necessarily remain uncertain.

Audouinella microscopica (Naegeli) Woelkerling 1971: 33, Figs. 10, 23A; 1972a: 85, Figs. 1-14.

Acrochaetium microscopicum (Naegeli in Kuetzing) Naegeli 1861: 407, Figs. 24-25.

Callithamnion microscopicum Naegeli in Kuetzing 1849: 640.

Chantransia microscopica (Naegeli in Kuetzing) Batters in Schiffner 1916: 136, Figs. 13-18.

Chromastrum microscopicum (Naegeli in Kuetzing) Papenfuss 1945: 322.

Kylinia microscopica (Naegeli in Kuetzing) Kylin 1944: 13. Papenfuss 1947: 437.

Rhodochorton microscopicum (Naegeli in Kuetzing) Drew 1928: 151, 163.

Acrochaetium catenulatum Howe 1914: 84, pl. 31, Figs. 12-18.

Chantransia catenulata (Howe) DeToni 1924: 44.

Kylinia catenulata (Howe) Kylin 1944: 13.

Rhodochorton catenulatum (Howe) Nakamura 1941: 273, 280, Fig. 1.

Acrochaetium collopodum (Rosenvinge) Hamel 1927: 81.

Chantransia collopoda (Rosenvinge) Rosenvinge 1909: 81.

Chromastrum collopodum (Rosenvinge) Papenfuss 1945: 320.

Kylinia collopoda (Rosenvinge) Kylin 1944: 13, 15, Fig. 6.

Acrochaetium compactum Jao 1936: 241, pl. 10, Figs. 6-14.

Chromastrum compactum (Jao) Papenfuss 1945: 321.

Kylinia compacta Papenfuss 1947: 436.

Acrochaetium crassipes (Boergesen) Boergesen 1915: 20, Figs. 11-13. Boergesen 1927: 12, Fig. 5. Collins and Hervey 1917: 96. Howe 1918: 511. Taylor 1941: 75.

Chantransia crassipes Boergesen 1909: 1, Fig. 1. Taylor 1928: 134, pl. 28, Fig. 16.

Chromastrum crassipes (Boergesen) Papenfuss 1945: 321.

Kylinia crassipes (Boergesen) Kylin 1944: 13. Taylor 1960: 300.

Acrochaetium microfilum Jao 1936: 240, pl. 10, Figs. 1-5. (Non *A. microfilum* Levring 1945: 12, Fig. 4. = *A. Levringii* Papenfuss 1947: 436).

Acrochaetium moniliforme (Rosenvinge) Boergesen 1915: 22.

Chantransia moniliformis Rosenvinge 1909: 99, Figs. 28-29.

Chromastrum moniliforme (Rosenvinge) Papenfuss 1945: 322.

Kylinia moniliformis (Rosenvinge) Kylin 1944: 13.

Rhodochorton moniliforme (Rosenvinge) Drew 1928: 151, 164.

Plants epiphytic or epizoic, up to 75μ tall; original spore persisting as a unicellular base slightly smaller to slightly larger than other cells. Filaments of erect system 1-3, commonly acurate, simple or with a few secundly to irregularly arranged laterals. Cells barrel shaped to cylindrical, 5-9μ wide and 5-10μ long (L/D .75-2); each cell containing a parietal irregularly lobate chromoplast with one pyrenoid. Unicellular hairs up to 75μ long occur.

Monosporangia ovoid, 4-7μ wide and 5-8μ long, terminal or lateral, single or rarely in pairs, sessile or stalked, adaxially seriate or occasionally more scattered.

Other reproductive structures not observed.

Type Locality. — Torquay, England.

Holotype. — L, No. 940285 . . . 306.

Distribution. — Nearly cosmopolitan.

Hosts. — *Dictyota*, *Sphacelaria*, and hydroids in Sargasso Sea; a wide variety of algae elsewhere.

Specimens examined. — **Sargasso Sea:** 32° 09′N-60° 58′W, 16.v. 1970, *Woelkerling* (WJW 3232); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2215), 7.iii.1970, *Volkmann* (WJW 2408). **England:** Torquay, 1845, *Naegeli* (L 940285 . . . 306, type).

Two of the three Sargasso Sea collections (WJW 2215, WJW 2408) contain only several plants each of *A. microscopica*. The other collection (3232) contains numerous plants on a fragment of *Dictyota* collected about 14 km. off Bermuda; it seems likely that the host had drifted out from shore. The apparent rarity of *A. microscopica* in the western Sargasso Sea suggests that it may not be a permanent component of the flora.

Woelkerling (1972a) has recently presented a detailed account of this species including descriptions of sexual stages and has reduced to synonymy of a number of allied taxa cited as references in this account.

Audouinella thuretii (Bornet) Woelkerling 1971: 36, Figs. 12, 24.

Acrochaetium thuretii (Bornet) Collins et Hervey 1917: 98. Taylor 1960: 310.

Chantransia thuretii Bornet. Collins 1900: 49 (Nom. Nud.)

Chantransia thuretii (Bornet) Kylin 1907: 119, Fig. 28.

Rhodochorton thuretii Drew 1928: 171.

Chantransia corymbifera Thuret in LeJolis 1863: 107 (in part; see Papenfuss 1945: 313 under *Acrochaetium bornetii*.

Chantrancia efflorescens var *thuretii* Bornet 1904: XVI, pl. 1. Collins 1906: 196.

Plants epiphytic, caespitose, up to 5 mm. tall; original spore nonpersistent. Prostrate system consisting of branched filaments more or less forming a pseudoparenchymatous disc. Erect filaments freely and irregularly branched and sometimes tapering towards the tips; unicellular hairs not present. Cells of main axes and laterals 8-12(-16)μ wide and 20-80μ long (L/D (2-)3-5(-8)), sometimes tapering to 4-7μ wide near the apices; each cell containing a parietal lobate chromoplast and one pyrenoid.

Monosporangia ovoid, 8-12μ wide and 16-24μ long, solitary or occasionally in pairs, sessile or sometimes stalked,

generally situated adaxially on the lower portions of lateral branches but occasionally more scattered and/or terminal. Tetrasporangia ovoid to globose, 16-24μ wide and 20-30μ long, solitary or occasionally in pairs, sessile or occasionally stalked, scattered over laterals and main axes.

Other reproductive structures not observed.

Type Locality. — Cherbourg, France.

Holotype. — PC.

Distribution. — Nearly cosmopolitan.

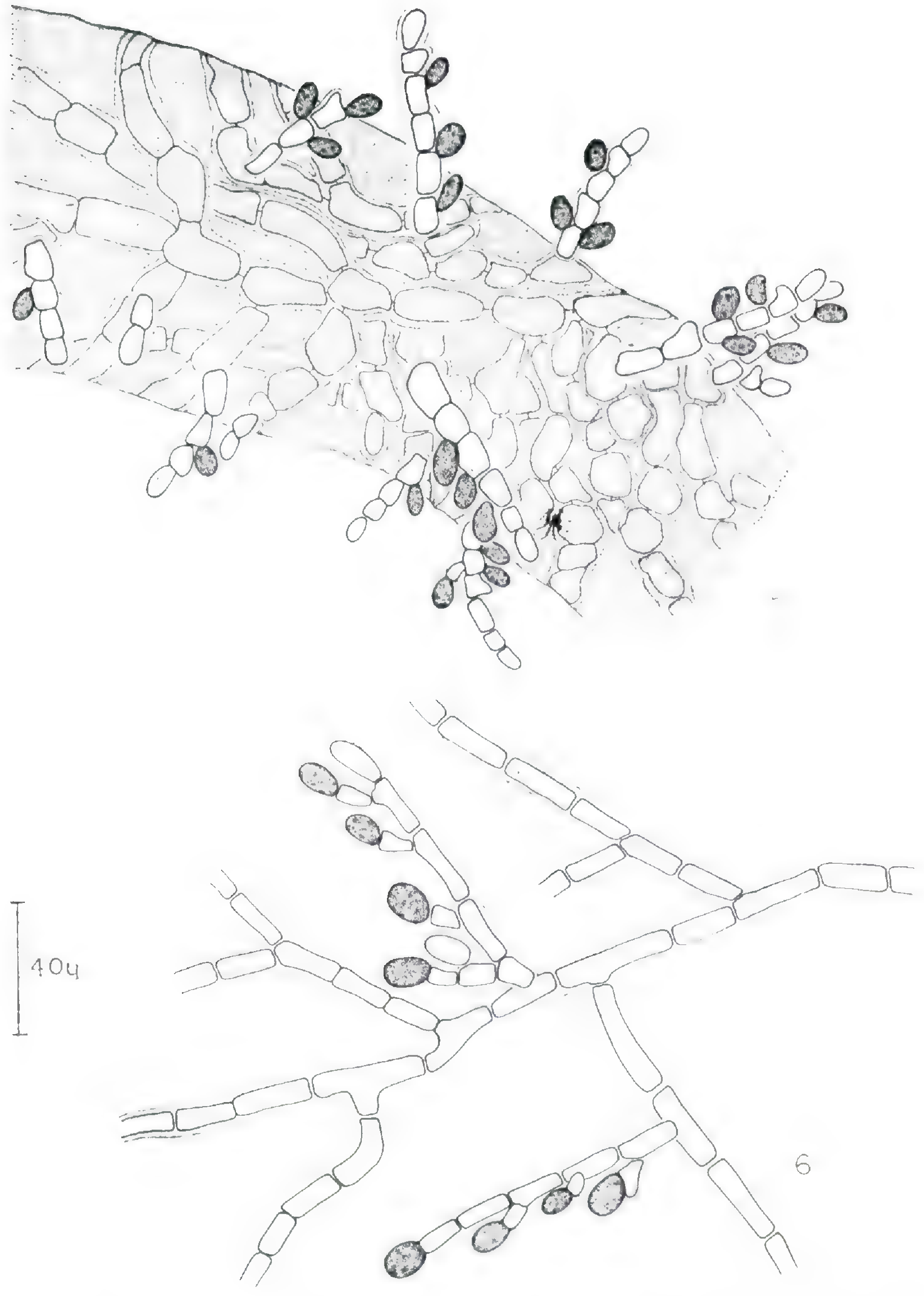
Hosts. — *Sargassum natans* and *Sargassum* sp. in Sargasso Sea; elsewhere on a variety of algae and marine angiosperms.

Specimens examined. — **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2424); 31°N-69° 29′W, 3.iii.1970, *Volkmann* (WJW 2379); 33° 58.5′N-69° 56.5′W, 15.v.1970, *Woelkerling* (WJW 2592); 34°N-70°W, 10.i.1970, *Volkmann* (WJW 2203); 36°N-70° 36′W, 9.xii. 1970, *Moore* (WJW 2934), (WJW 2943); 37°N-70°W, 12.v.1970, *Woelkerling* (WJW 3221); 38° 22′N-70° 58′W, 12.x.1970, *Volkmann* (WJW 2889).

Specimens of *Audouinella thuretii* agree in general with descriptions of Rosenvinge (1909) and Woelkerling (1971). Sexual plants are described in detail by Kylin (1907).

The relationship of *A. thuretii* to other audouinelloid algae requires further investigation. Two similar species — *Acrochaetium avrainvillae* Boergesen (see Boergesen 1915, p. 48, Figs. 47-49) and *A. Nemalionis* (DeNotaris) Bornet (see Collins and Hervey 1917, p. 98; Taylor 1960, p. 314) — occur in the Sargasso Sea region (Virgin Is. and Bermuda, respectively), but until the types and other collections of all three taxa can be compared, they are best maintained as distinct species. The major difference between *A. Nemalionis* and the Sargasso Sea specimens of *Audouinella thuretii* is apparently the lack of a funiform prostrate system in the latter, and this difference is of doubious taxonomic value (Woelkerling 1971).

Colaconema infestans (Howe et Hoyt) comb. nov. Figs. 5-6.
Acrochaetium infestans Howe et Hoyt 1916: 116, pl. 14. Howe 1918: 511. Hoyt 1920: 473, pl. CXVIII.



Figs. 5-6. *Colaconema infestans* (Howe et Hoyt) comb. nov. Habit of monosporangial plant (Shaded portion represents host).

Chantransia infestans (Howe et Hoyt) DeToni 1924: 64.
Chromastrum infestans (Howe et Hoyt) Papenfuss 1945: 324.
Kylinia infestans (Howe et Hoyt) Papenfuss 1947: 438. Taylor 1960: 301.
Rhodochorton infestans (Howe et Hoyt) Drew 1928: 151, 187. Nakamura 1944: 118, Fig. 13.
Rhodochorton membranaceum auct. non. (Magnus) Hauck: Collins and Hervey 1917: 148.

Plants partly endozoic, more or less stoloniform, up 90μ tall, exclusive of hairs. Prostrate system consisting of branched, stoloniferous filaments creeping just beneath the surface of the host, sometimes becoming very conjested and appearing pseudoparenchymatous; cells cylindrical to irregular in shape, 4-6(-10)μ wide and 5-40μ long (L/D 1-8). Erect filaments arising more or less perpendicularly from the prostrate system, simple or sparingly and irregularly branched, occasionally bearing terminal hairs up to 125μ long. Cells cylindrical, 3-7μ wide and 6-30μ long (L/D 2-5), each bearing a single parietal lobate chromoplast with one pyrenoid.

Monosporangia ovoid, 4-6(-8)μ wide and 6-10(-15)μ long, sessile or stalked, borne singly or in pairs, scattered over the erect filaments.

Other reproductive structures not observed.

Type locality. — A reef about 37km. off of Beaufort, North Carolina.

Holotype. — NY.

Distribution. — Sargasso Sea; Bermuda, Japan, North Carolina.

Hosts. — Hydroids.

Specimens examined. — **Sargasso Sea:** 26° 50′N-71° 48′W, 5.iii.1970, *Volkmann* (WJW 2420); 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 3432); 31°N-69° 29′W, 3.iii.1970, *Volkmann* (WJW 2389); 34°N-70°W, 7.iii.1970, *Volkmann* (WJW 2403), 30.vi.1970, *Volkmann* (WJW 2725), 6.vii.1970, *Volkmann* (WJW 2749); 35° 54′-70° 30′W, 13.viii.1970, *Moore* (WJW 2902); 36°N-70° 36′W, 9.xii.1970, *Moore* (WJW 2949), (WJW 2938); 36° 28′N-70° 29′W, 15.viii.1970,

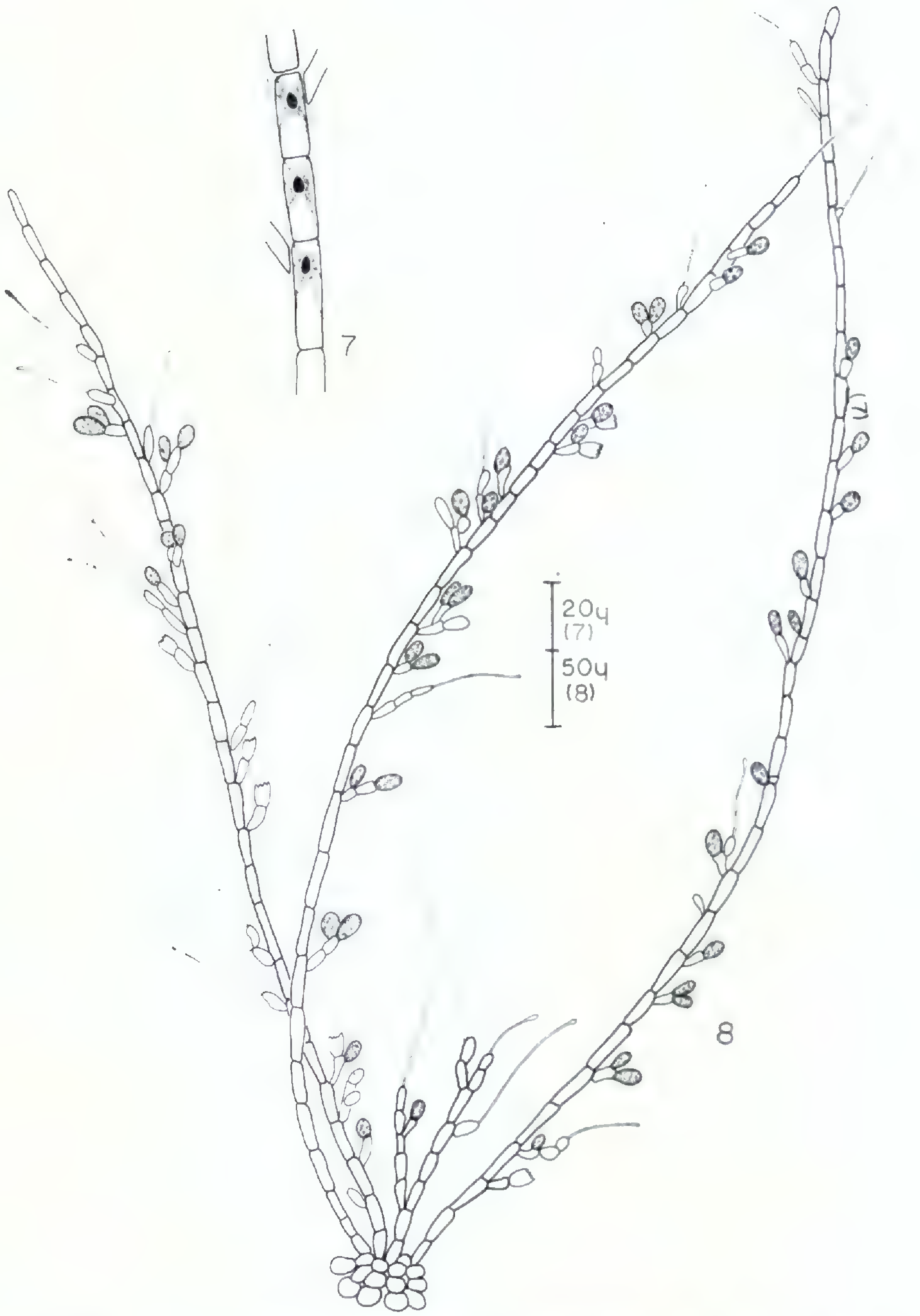
Moore (WJW 2907); 37° 30′N-70°W, 8.vii.1970, *Volkmann* (WJW 2706); 38° 22′N-70° 58′W, 12.x.1970, *Volkmann* (WJW 2887); 39° 07′N-70° 35′W, 16.viii.1970, *Moore* (WJW 2917), (WJW 2929); 39° 30′N-71°W, 6.x.1970, *Volkmann* (WJW 2810). **United States:** Beaufort, N. Carolina, 11.viii.1914, *Radcliffe* (NY, type).

Specimens of *Colaconema infestans* from the Sargasso Sea agree in general with the type material on a prepared slide in NY. This species occurs very commonly in the Sargasso Sea and has been found in nearly every collection of *Sargassum* bearing the hydroid hosts. Erect filaments rarely exceed 10 cells in length, and laterals normally do not exceed four cells in length.

The relationships of *C. infestans* to a number of other audouinelloid algae of similar morphology requires clarification. *Acrochaetium effusum* Levring 1953, p. 479, Figs. 13F-G and *Rhodochorton penetrale* Drew 1928, p. 187, pl. 44, Figs. 57-58, pl. 45, Figs. 59-60 do not appear to differ significantly from *Colaconema infestans* and a comparison of the types will probably show the three taxa to be conspecific. *Chantransia endozoica* Darbishire 1899, p. 13, pl. 1 appears to have larger cells, and further study is needed to determine whether intermediate forms occur. Pending the results of such investigation, *C. endozoica* and *Colaconema infestans* are maintained as distinct species.

The relationships of *Colaconema infestans* to a number of adouinelloid taxa growing on plant hosts also requires clarification, especially since host specificity does not appear to be a reliable criterion of specific distinction (Woelkerling 1971). Endophytic taxa of similar morphology include *Acrochaetium antillarum* Taylor 1942, p. 78, pl. 2, Figs. 3-4, *A. endophyticum* Batters 1896, p. 386. *Chantransia emergens* Rosenvinge 1909, p. 128, Fig. 55, and *Colaconema porphyrae* (Drew) Woelkerling (see Drew 1928, p. 188, pl. 46, Figs. 70-75; Woelkerling 1971, p. 50, Figs. 20, 27B), and critical studies on the types and other collections of these taxa may show some or all to be conspecific.

Further investigations are also needed to determine



Figs. 7-8. *Colaconema secundata* (Lyngbye) comb. nov. Fig. 7. Chromoplasts in vegetative cells. Fig. 8. Habit of fairly small monosporangial plant.

whether or not *Colaconema bonnemaisoniae* Batters and related taxa (see Woelkerling 1971, p. 42) possibly represent prostrate system stages of *C. infestans.*

Specimens of Collins and Hervey (1917, p. 148) from Bermuda referred to *Rhodochorton membranaceum* (Magnus) Hauck and distributed in the PBA, Vol. XLIV, No. 2194 (Collins, Holden, and Setchell 1917) have been examined and found to be plants of *Colaconema infestans.* Howe (1918, p. 511) reached the same conclusion.

Colaconema secundata (Lyngbye) comb. nov. Figs. 7-8.

Acrochaetium secundatum (Lyngbye) Naegeli 1861: 405.

Callithamnion secundatum (Lyngbye) C. Ag. 1828: 187.

Ceramium secundatum (Lyngbye) C. Agardh 1824: 132.

Chantransia secundata (Lyngbye) Thuret *In* Le Jolis 1863: 106.

Chromastrum secundatum (Lyngbye) Papenfuss 1945: 323.

Kylinia secundata (Lyngbye) Papenfuss 1947: 437.

Callithamnion daviesii var. *secundatum* Lyngbye 1819: 129, pl. 41, Fig. B4-6.

Acrochaetium luxurians (J. Agardh) Naegeli 1861: 405.

Callithamnion luxurians J. Agardh 1851: 14.

Chantransia luxurians (J. Agardh) Kylin 1907: 117, Fig. 26.

Acrochaetium virgatulum (Harvey) Bornet 1904: XXII. Boergesen 1927: 14, Figs. 7-8. Chapman 1963: 56. Hoyt 1920: 473, Figs. 29-30. Taylor 1941: 75.

Callithamnion virgatulam Harvey *In* Hooker 1833: 349.

Chantransia virgatula (Harvey) Thuret *In* LeJolis 1863: 106. Rosenvinge 1909: 109, Figs. 37-41.

Chromastrum virgatulum (Harvey) Papenfuss 1945: 323.

Kylinia virgatula (Harvey) Papenfuss 1947: 437.

Rhodochorton virgatulum (Harvey) Rosenvinge 1935: 7.

Trentepohlia virgatula (Harvey) Farlow 1881: 109.

Plants epiphytic or epizoic, more or less virgate, up to 2mm. tall; original spore non-persistent. Prostrate system at first a parenchyma-like group of cells, later forming a small, more or less circular pseudoparenchymatous disc of one to several cell layers. Erect filaments nearly simple to moderately branched, commonly bearing short laterals giving plant a virgate appearance; terminal and pseudolateral hairs common. Cells of erect filaments cylindrical (6-) 8-12μ wide and (10-) 20-70μ long (L/D 1-7), each with a distinctly stellate chromoplast and one pyrenoid.

Monosporangia ovoid, (6-) 9-13μ wide and (10-) 16-24μ long, sessile or stalked, solitary, in pairs or occasionally in threes, commonly crowded laterally or terminally on the shorter laterals or occasionally more scattered.

Other reproductive structures not observed.

Type locality. — Kvivig, Faeroes Islands (on "*Conferva rupestris*").

Holotype. — C.

Distribution. — Sargasso Sea; Atlantic Shores of North America, Canary Islands, Europe.

Hosts. — *Sargassum fluitans, S. natans,* and hydroids in Sargasso Sea; a wide variety of algae elsewhere.

Specimens examined. — **Sargasso Sea:** 28°N-70°W, 4.iii.1970, *Volkmann* (WJW 2425); 31°N-69° 29'W, 3.iii.1970, *Volkmann* (WJW 2367); 39° 30'N-71°W, 6.x.1970, *Volkmann* (WJW 2865). **England:** Torquay, prior to 1833, *Griffiths* (TCD, type of *Acrochaetium virgatulum* (Harvey) Bornet). **Faeroes Islands:** Kvivig, 19.vi.1817, ? (C, Herb. Lyngbye, type). **Sweden:** Kattegat Channel, no date, ? (LD 35117, type of *Callithamnion luxurians* J. Agardh).

The few specimens of *Colaconema secundata* from the Sargasso Sea agree well with type material from the Faeroes Islands. Although an extremely variable species, *C. secundata* can be distinguished from other audouinelloid algae by the following combination of characters (in addition to cell and spore dimensions): 1) Spore germinating to form a distinctive parenchymatous group of cells which may later proliferate (see Kylin 1907, p. 115, Fig. 24;

Rosenvinge 1909, Figs. 37-41); 2) Cells with a distinctly stellate chromoplast with a centrally located pyrenoid, and in many cases 3) sporangia densely crowded on short lateral branches and 4) numerous terminal hairs, often terminating 1-2 celled branchlets. Tetrasporangia have not been observed but are reported by Hehre and Mathieson (1970), Kylin (1907, 1944), and Rosenvinge (1909) among others. Sexual stages remain unknown.

Unicellular hairs occur very commonly in *C. secundata* and often terminate 1-2 celled lateral branchlets, thus appearing stalked (Fig. 8).

In agreement with Hamel (1927, 1928) and Rosenvinge (1909), the taxa originally described as *Callithamnion luxurians* J. Agardh (1851, p. 14) and *C. virgatula* Harvey *In* Hooker (1833, p. 349) are considered conspecific with *Colaconema secundata.* The type collections of all three have been examined during this study and found to agree in all essential features. Since the specific epithet "secundata", first used by C. Agardh (1824, p. 132), predates the specific epithet "virgatula" (Harvey 1833) used by Hamel (1927, 1928) and Rosenvinge (1909) by nine years, it has nomenclatural priority.

Some authors (e.g. Kylin 1944, Taylor 1957) have maintained *C. secundata* and *Callithamnion* (= *Acrochaetium, Kylinia*) *virgatula* as distinct species on the bases of differences in the number of layers in the prostrate system or on slight differences in height, branching, or cell size, but as noted by Rosenvinge (1909), and as observed in New England collections (Woelkerling, unpublished data), considerable variation occurs in all cases, and species limits between the two taxa cannot be drawn reliably.

The taxonomy and relationships of *Colaconema secundata* to other taxa are quite involved and will be dealt with at a later date.

SUMMARY

The *Audouinella* complex is represented in the Western

Sargasso Sea by four species of *Audouinella* and two species of *Colaconema*, all newly recorded for this region. These species apparently constitute a permanent component of the Sargasso Sea flora, reproducing asexually by monospores and/or tetraspores. Species with a stoloniferous habit tend to produce more extensive prostrate systems than erect systems, whereas caespitose species usually possess better developed erect systems than prostrate systems. Critical comparisons of type and other collections indicate that *Acrochaetium dufourii* (Collins) Boergesen and *A. sargassi* Boergesen are conspecific with *Audouinella hallandica* (Kylin) comb. nov., and *Acrochaetium luxurians* (J. Agardh) Naegeli and *A. virgatula* (Harvey) Bornet are conspecific with *Colaconema secundata* (Lyngbye) comb. nov. Detailed descriptions of Sargasso Sea collections together with a taxononmic key are provided.

ACKNOWLEDGMENTS

Sincere thanks are due Mr. Gordon Volkmann of the Woods Hole Oceanographic Institution for making arrangements for the collection of samples in the Sargasso Sea and for making passage possible for the author on one of the cruises. Thanks are also due to the directors of various herbaria (C, L, LD, NMW,NY, TCD) for the loan of critical specimens. Miss Susan Heller kindly assisted in the preparation of drawings.

This study was supported in part by grant GB-13250 from the National Science Foundation to the Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Massachusetts.

REFERENCES

AGARDH, C. A. 1817. "Synopsis Algarum Scandinaviae." (Lund.)

————. 1824. "Systema Algarum." (Lund.)

————. 1828. "Species Algarum." Vol. 2, Pt. 3. (Lund.)

AGARDH, J. G. 1851. "Species, Genera et Ordines Algarum." Vol. 2, Pt. 1. (Lund.)

ARESCHOUG, J. S. 1847. Phycearum in maribus Scandinaviae crescunt, enumeratio. Nova Acta R. Soc. Scient. upsal. **13**: 223-382.

BATTERS, E. A. 1896. Some new British marine algae. J. Bot., Lond. **34**: 6-11; 384-390.

BOERGESEN, F. 1909. Some new or little-known West Indian Florideae. Bot. Tidsskr. **30**: 1-19.

———. 1914. The species of *Sargassum* found along the coasts of the Danish West Indies, with remarks upon the floating forms of the Sargasso Sea. Mindeskr. Japetus Steenstrups Føds. **2**(32): 1-20.

———. 1915. The marine algae of the Danish West Indies. Vol. II. Rhodophyceae. Dansk. bot. Ark. **3**: 1-80.

———. 1924. Plants from Beata Island, St. Domingo collected by C. H. Ostenfeld. 4. Marine algae. Dansk. bot. Ark. **4**(7): 14-35.

———. 1927. Marine algae from the Canary Islands. III. Rhodophyceae. Part I. Bangiales and Nemalionales. Biol. Meddr. **6**(6): 1-97.

BORNET, E. 1904. Deux *Chantransia corymbifera* Thuret. *Acrochaetium* et *Chantrancia*. Bull. Soc. bot. Fr. **51**(Suppl.): xiv-xxiii.

CARPENTER, E. J. 1970. Diatoms attached to floating *Sargassum* in the western Sargasso Sea. Phycologia **9**: 269-274.

CHAPMAN, V. J. 1963. The marine algae of Jamaica. Bull. Inst. Jamaica, Sci. Ser. **12**(2): 1-201.

COLLINS, F. S. 1900. Preliminary lists of New England plants. V. Marine algae. Rhodora **2**: 41-52.

———. 1906. *Acrochaetium* and *Chantransia* in North America. Rhodora **8**: 189-196.

———. 1911. Notes on algae. X. Rhodora **13**: 184-187.

———. 1917. The Sargasso Sea. Rhodora **19**: 78-84.

———., and HERVEY, A. B. 1917. The algae of Bermuda. Proc. Am. Acad. Arts Sci. **53**: 1-195.

———., HOLDEN, I., and SETCHELL, W. A. 1909. Phycotheca Boreali-Americana. XXXII.

———. 1917. Phycotheca Boreali Americana. XLIV.

CONOVER, J. and SIEBURTH, J. 1964. Effect of *Sargassum* distribution on its epibiota and antibacterial activity. Botanica mar. **6**: 147-157.

DARBISHIRE, O. V. 1899. *Chantransia endozoica* Darbish., eine neue Florideen-Art. Ber. dt. bot. Ges. **17**: 13-17.

De Toni, J. B. 1924. "Sylloge Algarum omnium hucusqua Cognitarium." Vol. 6-Florideae. (Padua.)

Dillwyn, L. W. 1802-1809. "British Confervae." (London.) [For details of dates of issue, see Bot. Notiser **113**: 317 (1960).]

Drew, K. M. 1928. A revision of the genera *Chantransia, Rhodochorton,* and *Acrochaetium* etc. Univ. Calif. Publs Bot. **14**(5): 139-224, Plates 37-48.

Farlow, W. G. 1881. The marine algae of New England. Rep. U.S. Commnr. Fish. for 1879, Appendix A-1: 1-210 (1882). [See Taylor 1957, p. 354 concerning the publication date of this paper.]

————. 1914. The vegetation of the Sargasso Sea. Proc. Am. Phil. Soc. **53**: 257-262.

Hamel, G. 1927. "Recherches sur les genres *Acrochaetium* Naeg. et *Rhodochorton* Naeg." Dissertation. (Paris.)

————. 1928. Sur les genres *Acrochaetium* Naeg. et *Rhodochorton* Naeg. Revue algol. **3**: 159-210.

Harvey, W. H. 1833. Cryptogamia algae. Div. II. Confervoideae. *In* W. J. Hooker, "The English Flora of Sir James Edward Smith". Class XXIV. Cryptogamia. Vol. 5. (London.)

————. 1852. Nereis Boreali-Americana. Part I. Melanospermae. Smithson Contr. Knowl. **3**(4): 1-150, pl. 1-12.

Hehre, E. J., and Mathieson, A. 1970. Investigations of New England marine algae. III. Composition, seasonal occurrence and reproductive periodicity of the marine Rhodophyceae in New Hampshire. Rhodora **72**: 194-239.

Hentschell, E. 1921. Ueber den bewuchs auf den treibenden Tangen der Sargassosee. Mitt. Zool. Staatsinst. Zool. Mus. Hamburg **38**: 1-26.

Howe, M. A. 1914. The marine algae of Peru. Mem. Torrey bot. Club **15**: 1-185, Plates 1-66.

————. 1918. Algae, pp. 489-540. *In* Britton, N. L. Flora of Bermuda. 1x + 585. New York.

————., and Hoyt, W. D. 1916. Notes on some marine algae from the vicinity of Beaufort, North Carolina. Mem. N.Y. bot. Gdn **6**: 105-23.

Hoyt, W. D. 1920. Marine algae of Beaufort, N.C. and adajacent regions. Bull. Bur. Fish., Wash. **36**: 367-556, Plates I-V.

Jao, C. C. 1936. New Rhodophyceae from Woods Hole. Bull. Torrey bot. Club **63**: 237-257.

Kuetzing, F. T. 1849. "Species Algarum." (Leipzig.)

Kylin, H. 1906. Zur Kenntnis einiger schwedischen *Chantransia*-arten. *In* "Botaniska Studier till F. R. Kjellman". pp. 113-26. (Uppsala.)

———. 1907. "Studien ueber die Algenflora der Schwedischen Westkueste." Dissertation. (Uppsala.)

———. 1944. Die Rhodophyceen der Schwedischen Westkueste. Acta Univ. lund. (N.F. Avd. 2) **40**(2): 1-104, taf. 1-32.

Lanjouw, J., and Stafleu, F. A. 1964. Index Herbariorum. Part I — The Herbaria of the World. 5th Ed. Regnum Vegetabile 31.

Le Jolis, A. 1863. "Liste des Algues Marines de Cherbourg." (Paris.)

Levring, T. 1945. Marine algae from some antarctic and sub-antarctic islands. Acta Univ. lund. (N.F. Avd. 2) **41**(7): 1-36.

———. 1953. The marine algae of Australia. I. Rhodophyta: Goniotrichales, Bangiales, and Nemalionales. Ark. Bot. (2)**2**(6): 457-530.

Lyngbye, H. 1819. "Tentamen Hydrophytologiae Danicae." (Copenhagen.)

Naegeli, C. 1861. Beitraege zur morphologie und systematik der Ceramiaceae. Sber. bayer. Akad. Wiss. **2**: 297-415.

Nakamura, Y. 1941. The species of *Rhodochorton* from Japan. I. Scient. Pap. Inst. Algol. Res. Hokkaido Univ. **2**(2): 273-291.

———. 1944. The species of *Rhodochorton* from Japan. II. Scient. Pap. Inst. Algol. Res. Hokkaido Univ. **3**(1): 99-119.

Papenfuss, G. F. 1945. Review of the *Acrochaetium — Rhodochorton* complex of the red algae. Univ. Calif. Publs Bot. **18**(14): 299-334.

———. 1947. Further contributions toward an understanding of the *Acrochaetium — Rhodochorton* complex of the red algae. Univ. Calif. Publs Bot. **18**(19): 433-447.

Parr, A. E. 1939. Quantitative observations on the pelagic *Sargassum* vegetation of the western Atlantic Ocean. Bull. Bingham oceanorg. Coll. **6**(7): 1-94.

Prat, H. 1935. Remarques sur la fauna et la flora aux sargasses flottantes. Naturaliste Can. **62**: 120-129.

Rosenvinge, L. K. 1909. The marine algae of Denmark. I. Rhodophyceae 1. K. danske Vidensk. Selsk. Skr. (Afd. 7, Raekke) **7**(1): 1-151.

———. 1935. Distribution of the Rhodophyceae in the Danish waters. K. danske Vidensk. Selsk. (Afd. 9, Raekke) **6**(2): 1-44.

Schiffner, V. 1916. Studien ueber Algen des Adraitischen Meeres. Wiss. Meeresunters. (Abt. Helgoland) (N.F.) **11**(2): 127-198.

Taylor, W. R. 1925. The marine flora of the Dry Tortugas. Revue algol. **2**: 113-135.

———. 1928. The marine algae of Florida with special reference to the Dry Tortugas. Pap. Tortugas Lab. **25**: 1-219.

———. 1941. Notes on the marine algae of Texas. Pap. Mich. Acad. Sci. **26**: 69-79.

———. 1942. Caribbean marine algae of the Allan Hancock Expedition, 1939. Rep. Allan Hancock Atlant. Exped., No. 2, pp. 1-193.

———. 1957. "Marine Algae of the Northeastern Coast of North America." 2nd Ed. (Ann Arbor.)

———. 1960. "Marine Algae of the Eastern Tropical and Subtropical Coasts of the Americas." (Ann Arbor.)

WINGE, O. 1923. The Sargasso Sea. its boundaries and vegetation. Rep. Dan. Exped. 1908-10 to the Mediterranean and adjacent seas, **3**(Misc): 1-34.

WOELKERLING, W. J. 1970. *Acrochaetium botryocarpum* (Harvey) J. Ag. in southern Australia. Br. phycol. J. **5**(2): 159-171.

———. 1971. Morphology and taxonomy of the *Audouinella* complex (Rhodophyta) in southern Australia. Aust. J. bot., Suppl. Ser. Suppl. **1**. 91 pp.

———. 1972a. Studies on the *Audouinella microscopica* (Naeg.) Woelk. complex (Rhodophyta). *Rhodora* **74**: 85-96.

———. 1972b. Some algal invaders on the northwestern fringes of the Sargasso Sea. *Rhodora* **74**: 295-298.

DEPARTMENT OF BOTANY
UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN 53706

SALT CONCENTRATIONS IN GROUND WATERS BENEATH RHIZOPHORA MANGLE AND AVICENNIA GERMINANS

LORING MORROW
AND NORTON H. NICKERSON[1]

The purpose of this investigation was to determine whether salinity of ground water beneath *Rhizophora mangle* L., (red mangrove), and *Avicennia germinans* (L.) L., (black mangrove), was correlated with the distribution of these species. It was expected that there might be a mixture of fresh ground water and tidal salt water and that the levels of resulting salinity might be a deciding factor in their distribution. Moog (1963) stated on the basis of his preliminary studies that *A. germinans* was regulated by this salt variation. He found that in salt pools where there was a high concentration of salt (higher than sea water) the growth of *A. germinans* was dwarfed and the trees grew poorly, growing only approximately 2 cm. per year. Individuals of the marsh area, he reported, thrived, growing 8 to 30 cm. per year. Moog ascribed this difference to the fact that they were in contact with fresh water daily at high tide when the underlying fresh-water table was raised due to tidal pressure.

The method of testing was to drill a hole near the base of the individual of a particular species with a three-foot-long hand auger. Next a small hand pump with a two-foot-long hose was put into the hole and a sample of water was taken. This sample was kept in a sealed glass test tube and later that day tested for conductivity with a Beckman conductivity bridge, Model RC-19, which gives its results

[1]This work was supported by grants from the Hurdle Hill Foundation, the Arnold Bernhard Foundation and the Faculty Research Fund of Tufts University. Thanks are gratefully extended to Dr. R. A. Howard, Director, Arnold Arboretum, Harvard University, for permission to utilize his as yet unpublished updated Bahamian plant nomenclature.

in micromhos per centimenter (μmho/cm). Conductivity is the reciprocal of resistivity and is expressed in mho/cm (mho = 1/ohm, μmho = $1/10^6$ ohms). This technique does not indicate salinity directly, but does give conductivities which can be compared to the conductivities of sea water and of fresh water. A higher conductivity would mean higher concentration of salts, of which, in sea water, sodium chloride would be predominant.

The samples were taken during January, 1971, on five cays (Coakley, Bowe, Ben Rolle, Hummingbird and Culmer's) of the Jewfish Chain, which runs westward at 23.5°N from George Town, Great Exuma, in the Bahamas. Hummingbird Cay and the other islands are discussed further in a study now in preparation (Nickerson et al, 1973).

Several samples of open sea water were tested; they displayed a conductivity of 62.7k umho/cm. In contrast, fresh water from a well on Hummingbird Cay, site of the Hummingbird Cay Foundation's Biological Laboratory, displayed a conductivity of 1.03 μmho/cm. These values mean resistances of approximately 16 ohms for 1 cm of seawater and 1000 ohms for 1 cm of fresh water. They also mean for seawater, about 37,000 ppm NaCl at 25°C. and for the well sample, about 450 ppm NaCl at 25°C.

Very few *Laguncularia racemosa* (L.) Gaertn. (white mangrove) were tested because the soil was usually too dry beneath them to obtain a sample. The one that could be tested had a conductivity of 62.9k. This species is not dealt with further in this study.

Fifteen samples were taken from areas in which *Rhizophora mangle* grew exclusively. The average conductivity was 63.2k, approximately that of sea water.

Sixteen samples were taken from areas where *Avicennia germinans* occurred exclusively. They had a much higher average conductivity (72.1k), with the highest individual sample at 88.8k. In areas where both *A. germinans* and *R. mangle* were found in approximately the same numbers, the average of eight samples was 67.7k, approximately midway

between the other two averages. These data are summarized in Table I.

The areas where *A. germinans* was found were usually depressions, often partly filled with sand, where the salt ocean water flowed in at high tide and stayed even after the tide went out. This condition would form a salt pool, which the results show, because the water apparently evaporated and left the salt behind. Our results were quite consistent. There were only two black mangrove areas with salinity equal to sea water, and we were unable to determine the shape of the underlying rocks in these areas with any degree of reliability. These results are interpreted to mean that *A. germinans* grows where it does because of a higher concentration of salt in the ambient water than that found in sea water. Whether *A. germinans* needs the higher concentration of salt or whether it just tolerates it is another question to which these data do not speak.

Moog (1963) noted that the osmotic pressure in *A. germinans* is 21.5 atm. and in *R. mangle* it is 27 atm. The energy required to remove only water from sea water should be less with increased internal osmotic pressure and thus it would presumably be easier for *R. mangle* to obtain fresh water from sea water. *A. germinans,* however, secretes salt (NaCl) in large quantities on its leaves: hence it must absorb salt water from its environment. It is also possible that *A. germinans* grows in salt pools because of the lack of competition from other plants. There are solid stands of *A. germinans* in inland salt-pool areas on several islands of the Jewfish chain.

Rhizophora mangle is always found in either open sea water or in tidal flat areas that are covered with large quantities of new sea water each day at high tide. The conductivity of water samples obtained beneath these *R. mangle* colonies at the time of testing was always close to that of sea water. Davis (1943) reported that *R. mangle* will live at least six years in a greenhouse with only fresh water, which indicates that it can perhaps adapt to fresh water. Against this evidence is a color infra-red aerial photograph of the

Marco Island area of western Florida, which shows a progressive color change, interpreted as slow dying of mangrove swamps from which the sea has been excluded by diking (Nickerson, 1971, Plate 4.)

Our evidence indicates that *R. mangle* survives only in areas where salinity approximates that of sea water, and where sea water is free to exchange with the ocean at each tide. It indicates that *A. germinans* thrives in areas where salinities consistently exceed that of sea water, and where there is not a free exchange of root-bathing waters with the ocean at each tide.

TABLE I
TABLE OF CONDUCTIVITIES
FOR EACH WATER SAMPLE
(in thousands of μmhos/cm)

Rhizophora	*Avicennia*	*Rhizophora & Avicennia*	*Laguncularia*
61.7	82.1	62.8	62.9
62.4	88.8	69.9	
57.7	71.5	68.8	
64.6	80.5	72.3	
65.6	70.2	72.3	
62.6	72.3	63.1	
63.5	70.2	67.3	
55.5	65.5	64.9	
55.7	63.9	av. 67.7	
58.7	69.2		
65.0	71.9		
69.9	78.6		
65.5	68.3		
70.5	74.4		
69.2	65.2		
av. 63.2	61.0		
	av. 72.1		

LITERATURE CITED

DAVIS, J. H., JR. 1943. The Natural features of South Florida. Department of Conservation Geological Bulletin 25: 1-31.

MOOG, A. O. D. 1963. A preliminary investigation of the significance of salinity in the zonation of species in salt-marsh and mangrove associations. South African Journal of Science 59(3): 81-86.

NICKERSON, N. H. 1971. Ecology and Everyman. Tufts Review, Winter 1970-71. Medford, Mass. pp. 20-25.

NICKERSON, N. H., SEMPLE, J. C., HOWARD, R. A., PHIPPEN, W. and TSCHUNKO, A. 1973. Ecology and vegetation of Hummingbird Cay, Jewfish Island Chain, Great Exuma, Bahamas. (in preparation.

DEPARTMENT OF BIOLOGY
TUFTS UNIVERSITY
MEDFORD, MASSACHUSETTS 02155

VARIATION OF SEED SIZE IN ATRIPLEX PATULA VAR. HASTATA (L.) Gray

FRANK R. DRYSDALE

Ungar (Rhodora 73:548-551, 1971) demonstrated seed dimorphism in *Atriplex patula* var. *hastata* (L.) Gray collected from saline marshes surrounding Lincoln, Nebraska. One kind of seed is small (1.0-1.7 mm) having a hard black testa and the other is usually larger (1.3-2.6 mm) having a soft yellowish-brown testa. Ungar (1971) shows a bimodal distribution of this condition. He has informed me that individuals of *A. patula* var. *hastata* do not yield equal numbers of each seed type, but he did not know the relative yields of each type.

In order to investigate this matter further, six lots of four to fourteen individuals each of *A. patula* var. *hastata* were harvested from an Alexander Township, Athens County, Ohio salt pan during October, 1971. Seeds were separated from fruits by chaffing. Small black seeds and larger brown seeds from each lot were counted (Table 1) and placed in separate envelopes. Samples from each category in each lot were placed on a piece of filter paper. With a dissecting

Table 1. Seed samples of *Atriplex patula* var. *hastata.*

	Lot					
	1	2	3	4	5	6
Number of plants	4	7	6	7	8	14
Total small seeds	255	961	87	1039	815	773
Sample size (sm. seed)	37	24	10	23	21	21
Total large seeds	14	72	28	56	63	25
Sample size (lg. seed)	14	22	13	9	18	16

Table 2. Size characteristics for seed of *Atriplex patula* var. *hastata.*

	Lot					
	1	2	3	4	5	6
Seed size (mm)	Number Sampled					
1.0		1		1		2
1.1	5	4		3	2	3
1.2	11	5	4	13	7	9
1.3	8	9	4	4	7	5
1.4	9	4	2	2	4	3
1.5	6		3		2	2
1.6	3	2	4	2	5	3
1.7	3		1	2	3	4
1.8	4	9		2	2	3
1.9	1	2		1	5	1
2.0	1	3	1	2	1	1
2.1		4	1		1	1
2.2		2	2			
2.6			1			

microscope and a calibrated ocular micrometer the diameter of each seed in each sample was measured (Table 2). By multiplying the reciprocal of the proportion of seeds sampled from each envelope times the number of seeds in each diameter size class an estimate of the absolute number of seeds in each size class was made (Table 3).

Table 3. Estimated number of seed in each size class in each lot sampled of *Atriplex patula* var. *hastata*.

Seed Size (mm)	Lot 1	2	3	4	5	6	Total Seeds
1.0		40		45		74	159
1.1	34	160		136	78	111	529
1.2	76	201	35	589	272	335	1508
1.3	55	361	35	182	272	185	1090
1.4	62	160	17	91	156	76	562
1.5	30		7		43	3	79
1.6	3	43	9	12	18	5	87
1.7	3		2	12	11	6	31
1.8	4	30	2	12	7	5	54
1.9	1	7		6	18	2	33
2.0	1	10	2	12	4	2	30
2.1		13	2		4	2	21
2.2		7	4				11
2.6			2				2

Figure 1 presents the estimated number of seeds in each size class in all lots. The log values for the estimated number of seeds in each size class in each lot are plotted in Figure 2.

These data indicate that rather than presenting equal numbers of seeds in each major size category, the large and the small of Ungar, there is a log normal distribution of seeds over each size class with considerably fewer seeds in the larger classes. They do not explain the presence of seemingly different colors of seeds; though pigmentation of the testa may be a product of pigment density and surface area with larger seeds having a lighter coloration due to more diffuse pigmentation. The data indicate that in the population seed size is log normally continuous, as opposed to bimodal. Also, the attendant observation of seeds of both colorations and major categories (large and small) on the

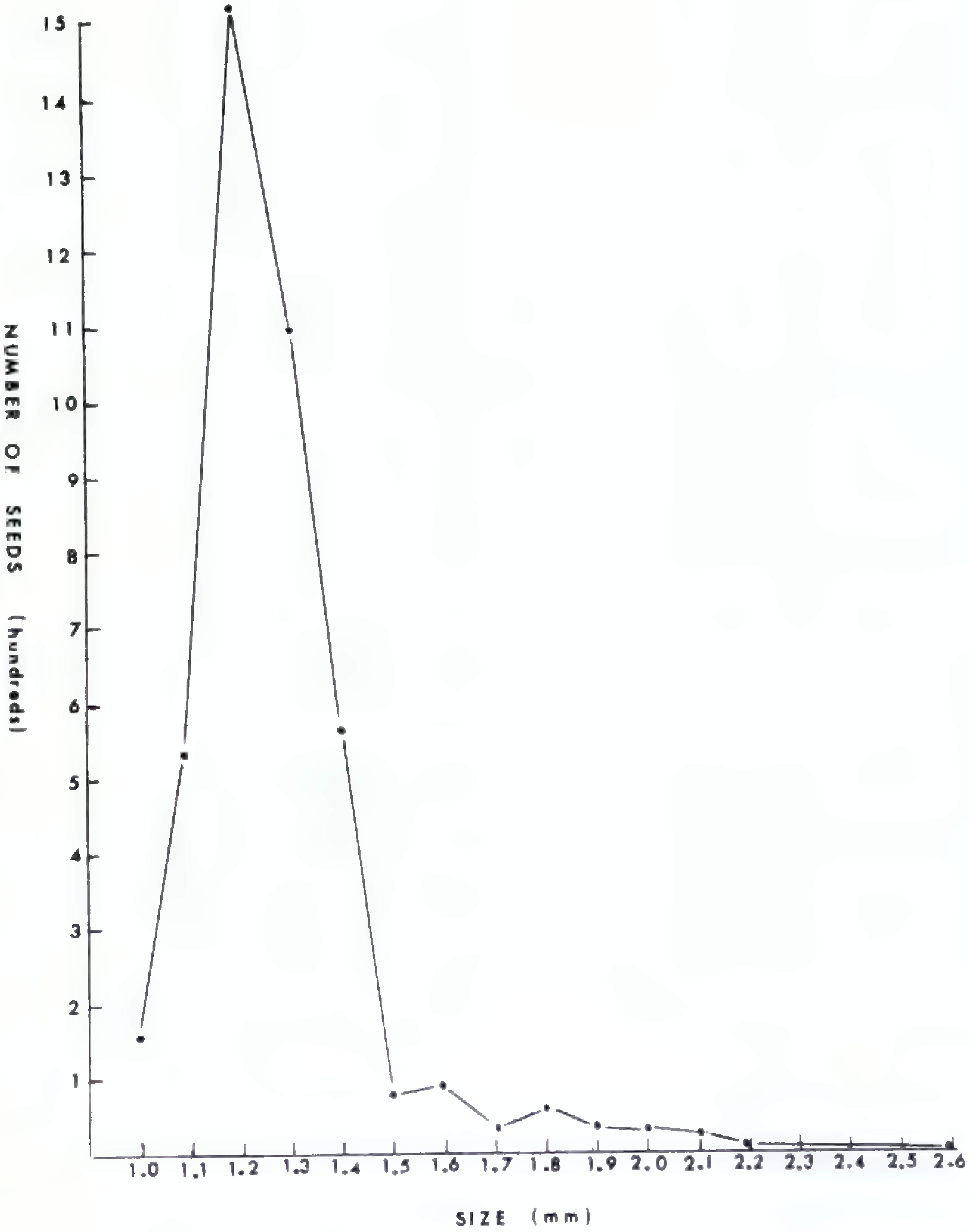


Figure 1. Estimated number of seeds in each size class for all lots of *Atriplex patula* var. *hastata*.

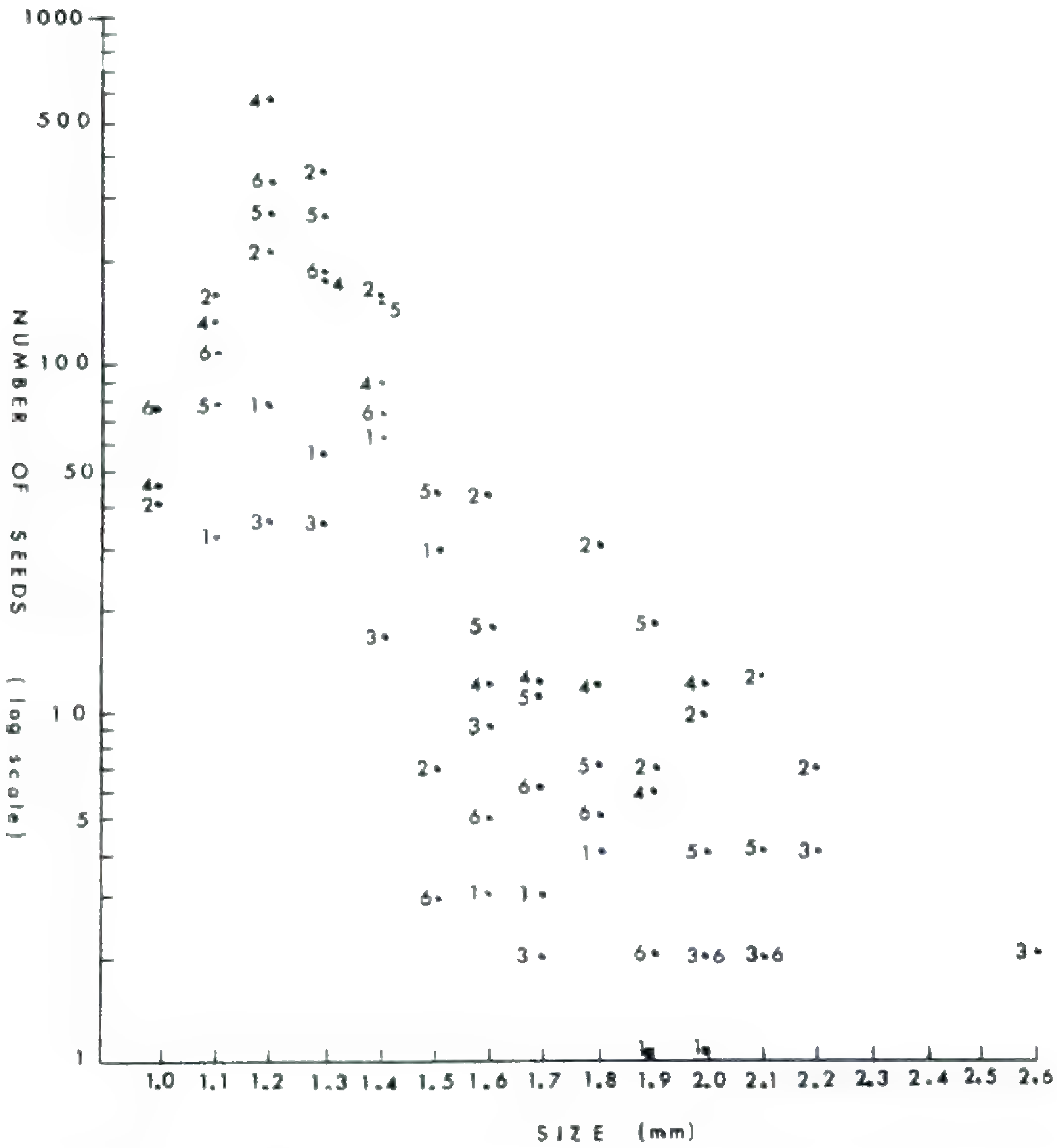


Figure 2. Log values for estimated numbers of seed in each size class for each of six lots of *Atriplex patula* var. *hastata.*

same plant indicates that seed morphism may be developmental.

DEPARTMENT OF BOTANY
OHIO UNIVERSITY
ATHENS, OHIO 45701

FLORAL DIMORPHISM IN RACHICALLIS AMERICANA (JACQ.) HITCH. (SALTWATER-BUSH)

Norton H. Nickerson[1]
and
Joseph W. Tripp

Hummingbird Cay is one of ten large oolitic limestone islands in the Jewfish Chain which runs westerly at 23.5°N from the George Town area of Great Exuma in the Bahamas. The island's ecology and flora are more fully described elsewhere (Nickerson *et al.*, in preparation). One member of the rocky-shore seaside plant communities is *Rachicallis americana* (Jacq.) Hitch. (Rubiaceae), listed by Britton and Millspaugh (1920) as a monotypic genus with 4 stamens and a half-superior, 2-celled ovary with slightly two-lobed, thick styles. Observation of many individual plants during early July of 1968 and 1969, the wet season when they are near their flowering peaks, showed that some bushes produced flowers with only bifurcate stigmas clearly visible, while others showed only 4 anthers. Since no mention was made by Britton and Millspaugh of this seeming dioecism, a careful study was made.

Many flowers on each of several different bushes were examined in the field in 1968. In 1969, branches laden with flowers in all stages of anthesis were collected from 32 randomly selected plants in five different locations. Ten flowers from each of these branches were carefully examined in the laboratory with a binocular microscope. Each flower was dissected by slitting the tube and flattening it slightly to observe the filaments, anthers, stigmas and style. The stamen-style form of each flower and each branch was noted

[1]This research was supported by grants from the Hurdle Hill Foundation to the Cape Cod Museum of Natural History, Brewster, Mass., and to Tufts University, and from the Arnold Bernhard Foundation to Earlham College, Richmond, Indiana.

and recorded. Pollen samples from flowers of each branch were compared with those of each other branch with a compound microscope. Dried specimens of representative branches were prepared and are deposited in the Herbarium of Tufts University, Medford, Mass. In 1970, 25 of these 32 plants were checked again; each exhibited the same sexual form as they had the previous year.

Foliage and branching habits of all the plants appeared to encompass the same amounts of variation. Flowers were dimorphic. Those in which the stigmas were clearly visible were perfect and had anthers on very short filaments well down the tube. Pollen was present. Those in which anthers were visible had longer filaments, occasionally with insertion higher up the tube, but not with anthers exserted. Stigmas and styles in such flowers were abortive, regardless of floral age. Ovaries were essentially equal in size in all flowers at this stage. All the flowers on any one plant were found to be identical with regard to form of stigmas, styles and filaments. The data are summarized in Table I.

Flowers of the two types occurred on separate plants. Both types of plants occurred at all but one of the sites sampled. Pollen was abundantly produced by both floral types and appeared alike in size and color under the compound microscope. Fruits were produced only on perfect-flowered individuals.

Perfect-flowered plants and male plants of *Rachicallis americana* occur in approximately equal numbers in this part of the Bahamas. There was no obvious correlation between geographic and/or ecological situation and expressed floral form, as Vuilleumier (1967) had noted might be present. Three plants of each type were known to be consistent in the sexual form of their flowers for the three seasons of 1968, 1969 and 1970. This case of floral dimorphism seems to be a further documentation of Vuilleumier's (1967) stand that many cases of floral dimorphism have been unreported by taxonomists.

The description of *Rachicallis americana* (Jacq.) Hitch. should be amended as follows: Plants of two types, bearing

TABLE I

Floral Dimorphism in *Rachicallis americana* (Jacq.) Hitch.

Location of Plant	Sexual Form of Individual Plants: Perfect Flowers	Sexual Form of Individual Plants: Male Flowers
Great Exuma, So. Dock (southeast-facing exposure)	6	3
Tommy Young Cay (west-facing exposure)	3	3
Culmer's Cay (south-facing exposure)	3	2
Hummingbird Cay		
South Coast	4	5
Northeast Coast	0	3
Total number of plants, each sexual expression:	16	16

dimorphic flowers either exclusively perfect with 4 stamens on very short filaments below the prominent bifurcate stigma, or exclusively with 4 anthers visible at the mouth of the tube and above the short aborted style and stigma. Fruits formed only on perfect-flowered plants.

LITERATURE CITED

Britton, N. L. & C. F. Millspaugh. 1920. (1962 reprint). The Bahama Flora. Hafner Publishing Co., Inc., N.Y., N.Y. 695 pp.

Nickerson, N. H., Semple, J. C., Howard, R. A., Phippen, W., & Tschunko, A. 1973. Ecology and Vegetation of Hummingbird Cay, Jewfish Island Chain, Great Exuma, Bahamas. (in preparation)

Vuilleumier, B. S. 1967. The origin and evolutionary development of heterostyly in the Angiosperms. Evol. 21: 210-226.

DEPARTMENT OF BIOLOGY
TUFTS UNIVERSITY
MEDFORD, MASSACHUSETTS 02155

UNIVERSITY OF MASSACHUSETTS
AMHERST, MASSACHUSETTS 01002

BOOK REVIEW

AQUATIC AND WETLAND PLANTS OF THE SOUTHWESTERN UNITED STATES[1]

This large and extensively illustrated treatment of the aquatic and wetland flora of Oklahoma, Texas, New Mexico, and Arizona, published by the Environmental Protection Agency, is timely, for it emphasizes the importance of basic information about plants for water conservation and water quality studies and programs. The Corrells interpret the aquatic and wetland environment broadly so that it includes many habitats ecologically peripheral to the rivers, streams, lakes, marshes and swamps of the region. This scope is important because it stresses the totality of wet areas of a watershed — the wet medows, bogs, and seepages that act as sponges to hold precipitation, the river and stream banks and floodplains that are important in erosional and depositional processes, as well as the lakes and rivers. The botany of the whole area involved in water quality and water use is thus included. The basic environmental message of this book — the integrity of the whole watershed and the basic role of plant life in its maintenance — should be appreciated by persons in charge of watershed protection and utilization.

The book is obviously important in another way, being a manual of a significant portion of the flora of the southwestern United States. The aquatic and wetland flora includes about 2100 species, representing 567 genera and 129 families. Most of the species grow in wet soil or in seasonally wet places. The Cyperaceae, Gramineae and Compositae are the dominant families, with a total of 590 species, rather few of them strictly aquatic. The wide range of plants brought into the treatment is also indicated, for example,

[1]Donovan S. Correll and Helen B. Correll. Aquatic and Wetland Plants of the Southwestern United States, i-xv, pp. 1-777, figs. 1-789. Environmental Protection Agency. 1972. (Price $7.75, Superintendent of Documents, United States Government Printing Office, Washington, D.C. 20402, Stock number 5501-0177).

by the presence of *Dodecatheon, Primula* and *Trifolium* (alpine springs and wet meadows), of *Marsilea* and *Elantine* (vernal pools), of *Populus* and *Salix* (borders of watercourses), and of *Amaranthus* (periodically inundated areas along rivers). The excellent illustrations of about 800 species, the keys, and the descriptions all facilitate accurate identification. The manual will have a wide use as a source of information about the species and for determinations. A printing error may be noted, the names on two figures have been reversed: Fig. 570 should be named *Myriophyllum pinnatum,* and Fig. 571 should be *Myriophyllum heterophyllum.*

This sizable volume adds to the impressive scope of works by Dr. Donovan Correll including books on the orchids of North America, on the potato and its wild relatives, on the ferns and fern allies of Louisiana, of Texas, and of Chihuahua, Mexico, as well as the most recent large publication on the flora of Texas (with M. C. Johnston). Dr. Helen Correll has contributed to the successful completion of these and has assumed a major role in the research and preparation of this publication on aquatic and wetland plants. This book by the Corrells is an important source of information on plants of the southwestern United States and will be especially useful for environmental studies related to water resources.

ROLLA TRYON
GRAY HERBARIUM AND DEPARTMENT OF BIOLOGY,
HARVARD UNIVERSITY

A NEW ALASKAN SPECIES OF ERIGERON L. (COMPOSITAE)[1]

STEPHEN A. SPONGBERG

During a study of variation patterns and the systematics of monocephalous species of *Erigeron* indigenous in arctic and cordilleran North America (Spongberg, 1971), a new species closely allied to the polymorphic, arctic-alpine species, *E. grandiflorus* W. J. Hooker, was discovered among herbarium collections from Alaska. It is a pleasure to name the new taxon in honor of Professor Eric Hultén, foremost authority on the Alaskan flora.

Erigeron Hultenii Spongberg, sp. nov. Figure 1.

Herba parva monocephala, e caudice perenni gracili decumbentique exoriens. *Folia* basalia pauca rosulata, 12-30 mm. longa, 2-6 mm. lata, lanceolata ad oblanceolata; folia caulina 3-5, foliis basilaribus similia, autem sessilia et superiora parum minora. *Involucrum* e phyllariis uniserialibus ca. 30 constatum; pagina abaxialis phyllarii trichomatibus multiserialibus unicellularibus dimorphis subtiliter hirsuta. *Capitula* gynomonoecia; radii flosculi exteriores femine ligulati 20-45, limbo corollae 5-9 mm. longo, 1-2 mm. lato; disci flosculi multi, corolla 2.5-3 mm. alta ad anthesin infundibuliformi; rami stylares 0.65-0.75 mm. longi. *Achenia* ovoidea hirsuta quadri-costata, costa omne filum vasculare adscendens in pariete achenii superjecta. Holotypus: Alaska: Campbell Creek Valley, 11 miles north of Anchorage, August 7, 1965, *L. Strutz, s.n.* (S).

Small, herbaceous perennial from a slender caudex, 2-4 mm. in diameter; flowering stem(s) monocephalous, 3-6.5 cm. high, pubescent with uniseriate trichomes. Basal leaves few, 2-5, lanceolate to oblanceolate, 1.2-3 cm. long, 2-6 mm.

[1]I wish to thank Dr. Elizabeth A. Shaw of the Gray Herbarium, Harvard University, for preparing the Latin description, and Miss Marion Seiler of the University of North Carolina, Chapel Hill, for her careful and precise skill in preparing the illustration.

Figure 1. A-F, *Erigeron Hultenii:* A, habit, × 1 1/3; B, head with involucre and ligulate florets, as pressed, × 1 1/3; C, phyllary, abaxial surface, ca. × 5; D, ligulate floret, ca. × 5; E, detail of basal portion of ligulate floret, ca. × 10; F, disc floret, ca. × 10.

wide, with an apiculate apex, short, basally dilated petioles, and slightly thickened, often red-tinged and ciliate entire margins; blades with a prominent midvein and 2 less prominent lateral veins, sparsely pubescent, moreso along the veins; cauline leaves 3-5, alternate, resembling the basal leaves but sessile, reduced in size only slightly along the stem. Involucre shallowly hemispherical, comprised of ca. 30 phyllaries in 1 series; phyllaries with prominent midveins, linear, 5-7 mm. long, 0.7-1.0 mm. wide, with recurved, acuminate apices; abaxial surfaces sparsely pubescent with glandular multiseriate and nonglandular uniseriate trichomes, the adaxial surface glabrous. Ligulate florets 20-45, the corolla drying pink to lavender, the limb linear, 5-9 mm. long, 1-2 mm. wide, often trifurcate at the blunt apex; tubular portion of the corolla ca. 1.5 mm. long, the style projecting well out of the orifice. Disc florets numerous, forming a disc 11-14 mm. in diameter; corollas pale yellow, funnel-form at anthesis, 2.5-3 mm. high, the 5 lobes 0.65-0.7 mm. high; anthers free at anthesis, the thecae 0.8-0.85 mm. long with a short appendage, 0.2-0.25 mm. long; pollen 98% normal, 19-24 μ in diameter; style branches 0.65-0.75 mm. long, the tips deltoid, collecting hairs not extending to the apices. Achenes ovoid, 4-ribbed (the ribs corresponding to 4 vascular traces); surface finely hirsute with short bristles; carpopodia 0.08-0.1 mm. high, 0.18-0.24 mm. broad; pappus single, comprised of 14-20 lucid, barbellate bristles up to 3.5 mm. long; pappus of the ligulate florets slightly exceeding the involucre, pappus of the disc florets equaling or slightly exceeding the disc corollas.

On the basis of its morphology, *Erigeron Hultenii* appears to be transitional between *E. peregrinus* (Pursh) Greene and species of the monocephalous complex, which centers around *E. grandiflorus* and includes, among other species, *E. simplex* Greene, *E. Muirii* A. Gray, *E. hyperboreus* Greene, and *E. uniflorus* L. ssp. *eriocephalus* (Vahl) Cronquist. *Erigeron peregrinus* is widespread in cordilleran North America, and Cronquist (1947, 1968) has considered

it to be the least derived species of sect. *Erigeron.* In its four-bundled achene vascularization, its linear or strap-shaped ligulate corollas, and its cauline leaves that remain relatively unreduced in size at progressively higher nodes, *E. Hultenii* resembles *E. peregrinus.* In its monocephalous habit, its reduced stem height and internode distance, its disc floret and carpopodium morphology, and its reduced number of pappus bristles, *E. Hultenii* is aligned with species of the monocephalous complex.

Judging from correlations between pollen size, pollen abortion percentages, chromosome number, and breeding behavior data obtained in studies of other monocephalous *Erigeron* species (Spongberg, 1971), *E. Hultenii* is probably a sexual diploid or tetraploid ($2n = 18$ or 36). Its close morphological resemblance to some plants of *E. grandiflorus* from Alaska, a taxon comprised of apomictic triploids ($2n = 27$) in the southern, Rocky Mountain part of its range (and, on the basis of pollen data, apomictic and triploid in Alaska as well), suggests that *E. Hultenii* may have been involved in the synthesis of certain apomictic races of *E. grandiflorus.* Although known only from the type locality (narrow endemism is frequent in *Erigeron*), this hypothesis assumes *E. Hultenii* had a once wider distribution.

LITERATURE CITED

Cronquist, A. 1947. Revision of the North American species of Erigeron, north of Mexico. Brittonia 6: 121-302.

———. 1968. The evolution and classification of flowering plants. x + 396 pp. Boston.

Spongberg, S. A. 1971. A systematic and evolutionary study of North American arctic and alpine monocephalous species of *Erigeron* (Compositae). Unpubl. Ph.D. Dissertation, Univ. North Carolina, Chapel Hill.

ARNOLD ARBORETUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

TRIBAL CLASSIFICATION OF TRIOSTEUM (CAPRIFOLIACEAE)

WALTER H. LEWIS and PAUL R. FANTZ

Traditionally the small genus *Triosteum* of disjunct Asian and eastern North American distribution has been included with *Viburnum* in the tribe Viburneae (Fritsch, Bot. Centralbl. **50**: 137-139, 1891; Wagenitz, Engler's Syllabus der Pflanzenfamilien, 473-475, 1964). This classification has been questioned in recent years as research from several disciplines has extended our understanding of the Caprifoliaceae, research to which we are now able to add data from cytology.

Wilkinson (Amer. J. Bot. **36**: 481-489, 1949) concluded that *Triosteum* differs too greatly from *Viburnum* by floral anatomy and morphology to be included in the same tribe. She found the former generalized and unspecialized compared with the unusual and complex structure of the flower of *Viburnum*. The irregular corolla and conspicuous sepal lobes of *Triosteum* reminded Wilkinson of some members of the Lonicereae and Linnaeeae, although she believed that the genus might be segregated as a distinct tribe. Metcalf & Chalk (Anatomy of the Dicotyledons **2**: 752-758, 1950) noted that cork usually arises in the pericycle region of the stem of *Triosteum*, which is also characteristic of the Linnaeeae, Lonicereae and Diervilleae, whereas its origin is superficial in species of *Viburnum*. Adding further question to the alignment of *Triosteum*, Erdtman (Pollen Morphology and Plant Taxonomy, Angiosperms, 97-99, 1966) noted that its pollen was essentially similar to that of the Linnaeeae-Lonicereae-Diervilleae group and he included *Triosteum* in the Lonicereae. Moreover, Bohm & Glennie (Canad. J. Bot. **49**: 1799-1807, 1971) found the presence of only flavone glycosides in *Triosteum*, which supports its removal from the Viburneae and relocation closer to *Lonicera*. In fact, Hutchinson (The Genera of Flowering Plants **2**: 81-89, 1967) suggested that *Triosteum* is probably little more than a reduced *Lonicera*, with

annual stems from a woody perennial rhizome, and the connate leaf-bases similar to those of the more advanced species of *Lonicera*. On this basis, however, Hutchinson separated the genus as the monotypic tribe Triosteae.

Members of the family differ in chromosome size, base number and ploidy. *Sambucus* and *Viburnum* have chromosomes much larger than all other genera varying in length from 4-5 μ (Sax & Kribs, J. Arnold Arb. 11: 147-153, 1930) with $x = 8$ or more commonly 9 for *Viburnum* (Egolf, J. Arnold Arb. 43: 132-172, 1962) and $x = 18$ and 19 for *Sambucus* (Ourecky, Amer. J. Bot. 57: 239-244, 1970). The remaining species studied have chromosome sizes averaging only 1-2 μ. Of these, members of the Linnaeeae typically have $x = 8$ primarily at the polyploid level, or less frequently $x = 9$ (*Symphoricarpus*) and then commonly polyploid. The Diervilleae characteristically have $x = 9$ and like *Symphoricarpus* are commonly polyploid. The Lonicereae also predominantly have $x = 9$, but largely at the diploid level.

To these results we add the chromosome number of *Triosteum*: $2n = 18$ ($x = 9$) based on *T. perfoliatum* L. from Missouri (Boone Co., Columbia, *Dunn s.n.* (MO); Dallas Co., Bennett Springs State Park, *Kastler s.n.* (MO); Franklin Co., Gray Summit Arboretum, *Fantz* 1386 (MO); and Maries Co., ca. 2 miles NE of Vienna on Rt. 2, *Fantz* 1128 (MO)). All counts are from root squashes, one plant from each population.

As the chromosomes of *Triosteum* approximate the size of those found for members of the Linnaeeae-Lonicereae-Diervilleae group in agreement with data from gross morphology, anatomy, palynology and chemistry, the exclusion of the genus from the Viburneae is clear. Having a base number of 9 and ploidy level of $2x$, similar to members of the Lonicereae, we propose the inclusion of *Triosteum* in this tribe. We find no evidence for its separation as a unique tribe.

DEPARTMENT OF BIOLOGY, WASHINGTON UNIVERSITY AND
THE MISSOURI BOTANICAL GARDEN
ST. LOUIS, MISSOURI 63110

CHROMOSOME PAIRING IN OBLIGATELY APOGAMOUS FERNS; PELLAEA ATROPURPUREA AND PELLAEA GLABELLA VAR. GLABELLA

Sylvia Jane Rigby

Obligate apogamy is a type of asexual reproduction, which is found in several genera of ferns, including *Pellaea,* the cliff brakes. Among the species of this genus which show obligate apogamy are two which can be found in northeastern North America, namely *Pellaea atropurpurea* (L.) Link and *P. glabella* Mett. ex Kuhn. As part of a more general investigation of these two species (Rigby 1968) cytological studies were made on their sporangia during sporogenesis.

In obligately apogamous ferns the sporophyte arises directly from the gametophyte without fertilization, while viable spores are still produced by meiosis as in sexually reproducing ferns. Therefore, a compensating mechanism is necessary to keep the chromosome number from being repeatedly reduced by meiosis from one generation to the next. Such a mechanism was observed by Steil (1919) and described in detail by Manton (1950). In the final mitotic division before meiosis the chromosomes of the spore mother cells divide, but the cells themselves do not, so that restitution nuclei are formed. Thus, instead of the sporangium containing sixteen spore mother cells each with the same chromosome number as the sporophyte plant, the sporangium contains only eight spore mother cells, each with double the sporophytic chromosome number. These spore mother cells can then go through a regular meiosis, producing thirty-two viable spores, each with the same number of chromosomes as the sporophyte.

This type of compensating mechanism does not occur in all the sporangia of the apogamous plant. Of the four types of sporangia found by Manton (1950) in varying proportions in the apogamous ferns she investigated, the two which seem to be most useful for cytogenetic studies are:

Type One — There is no premeiotic doubling of the chromosome number. Sixteen spore mother cells are formed and meiosis begins, but many of the chromosomes do not pair. This lack of pairing and irregular disjunction leads to spore abortion.

Type Two — The premeiotic doubling of the chromosome number gives eight spore mother cells, in each of which meiosis can take place with regular pairing between the newly doubled chromosomes. Thirty-two viable spores are produced.

Type Two sporangia, with their regular bivalents, can be used to determine the chromosome number of the species. In the Type One sporangia the chromosomes may not consist of two homologous sets, for pairing is irregular. Since many apogamous ferns are triploid or of a higher ploidy level and may owe their origin to hybridization, Manton (1950) suggests that the degree of homology between the genomes of the original parents of the cross may be deduced from examination of the pairing patterns in Type One sporangia.

Pellaea atropurpurea is an apogamous triploid, and the most common form of *P. glabella* var. *glabella* (the eastern variety of this species) is an apogamous tetraploid. The chromosome numbers of these two taxa have been established as 87 for *P. atropurpurea* and 116 for *P. glabella* var. *glabella* (Manton 1950; Tryon & Britton 1958). During the present study Type One sporangia of the two taxa were examined to ascertain, as far as possible, the relative proportions of univalents, bivalents and multivalents present in each. It was thought that these pairing patterns might give some indication as to the origin of these taxa, that is, whether they had arisen as autopolyploids or had begun as hybrids between two or more species.

MATERIALS AND METHODS

The sources of material used for studying the meiotic chromosomes were as follows:

Pellaea atropurpurea (L.) Link

(i) Spore-grown specimen. Source of spores, collection by *A. Monette,* Campbell's Bay, Quebec (DAO 26361).

(ii) Spore-grown specimen. Source of spores, collection by *T. M. C. Taylor,* Fairmount Hotsprings, British Columbia (UBC 37640).

P. glabella Mett. ex Kuhn var. *glabella*

(i) Spore-grown specimen. Source of spores, collection by *J. B. Clark,* Laclede Co., Missouri (OAC 37706).

(ii) Material collected in the field, by *S. J. Rigby,* Rockwood, Ontario.

Fertile pinnae were fixed in 3 parts absolute ethanol: 1 part glacial acetic acid (previously saturated with ferric acetate) for 3 to 8 days at 4°C and then transferred to 70% ethanol and stored at 4°C until examined. Sporangial squashes were made using the propionic-iron-haematoxylin technique described by Lu (1967), with the modification that Solution A was diluted with about an equal volume of 45% acetic acid, since otherwise there was a tendency for the iron to precipitate when the two solutions were mixed. Slides were made permanent by ringing the cover slip with Hoyer's mounting medium (formula given in Alexopoulos & Beneke 1952, p. 2). The chromosomes were observed and photographed under interference contrast (Zeiss-Nomarski) with an oil immersion objective (Planapo, N.A. 1.3). Because the chromosomes in the Type One spore mother cells do not separate readily at metaphase, it was hoped that the three dimensional effect of the interference contrast might make it easier to distinguish between two or more overlapping chromosomal associations. In cases where the cells could not be flattened into a single focal plane, photographs were taken of the same cell in several focal planes. Tracings from these photographs were compared with the original slides and used to make the explanatory diagrams.

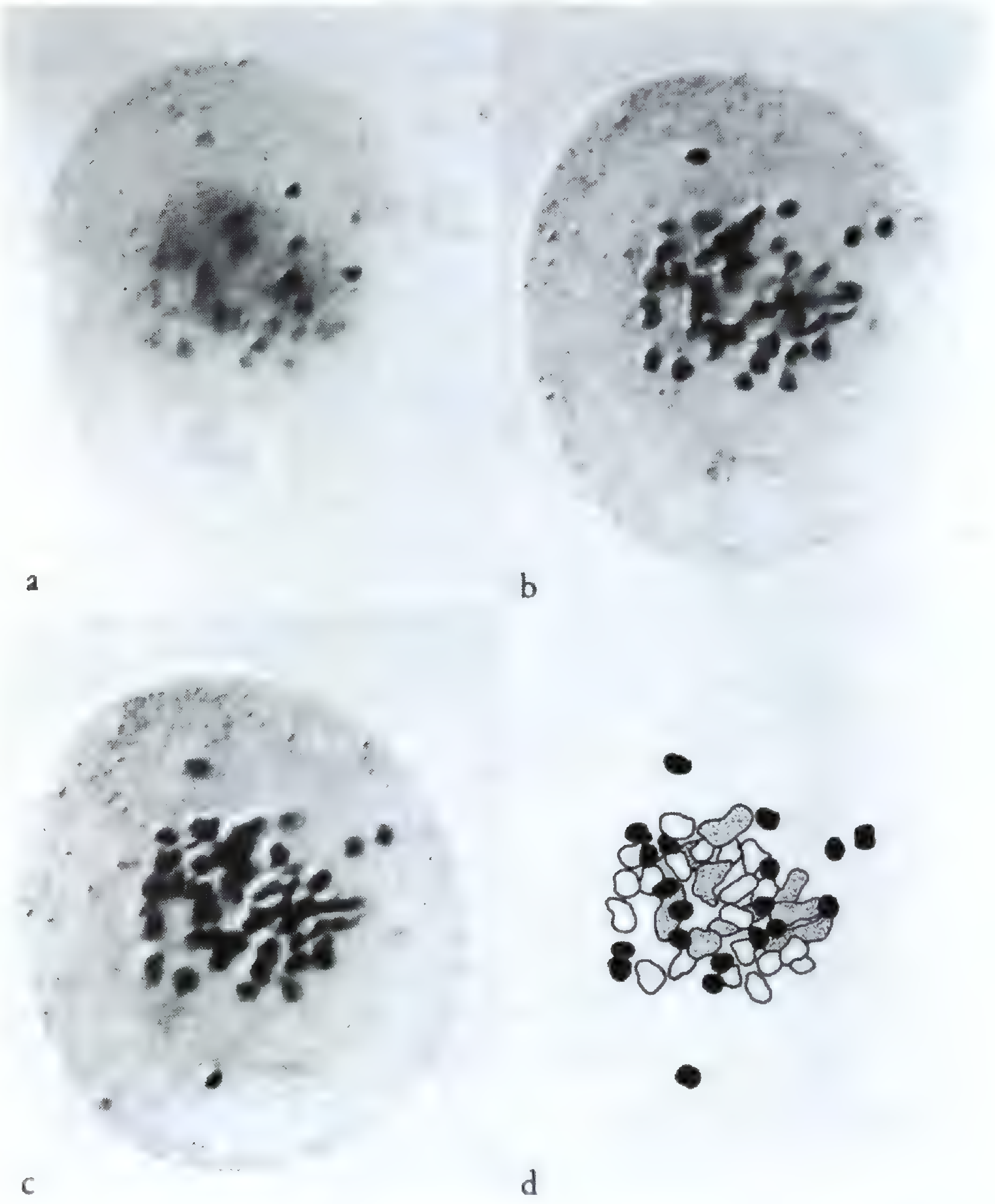


Figure 1. Spore mother cell from Type One sporangium of *Pellaea atropurpurea* (Campbell's Bay material) at meiosis. × 2000. a, b, c: Cell photographed in three different focal planes. d: Explanatory diagram, Interpretation: Univalents (black) 20, Bivalents (white) 20, Trivalents (stippled) 9.

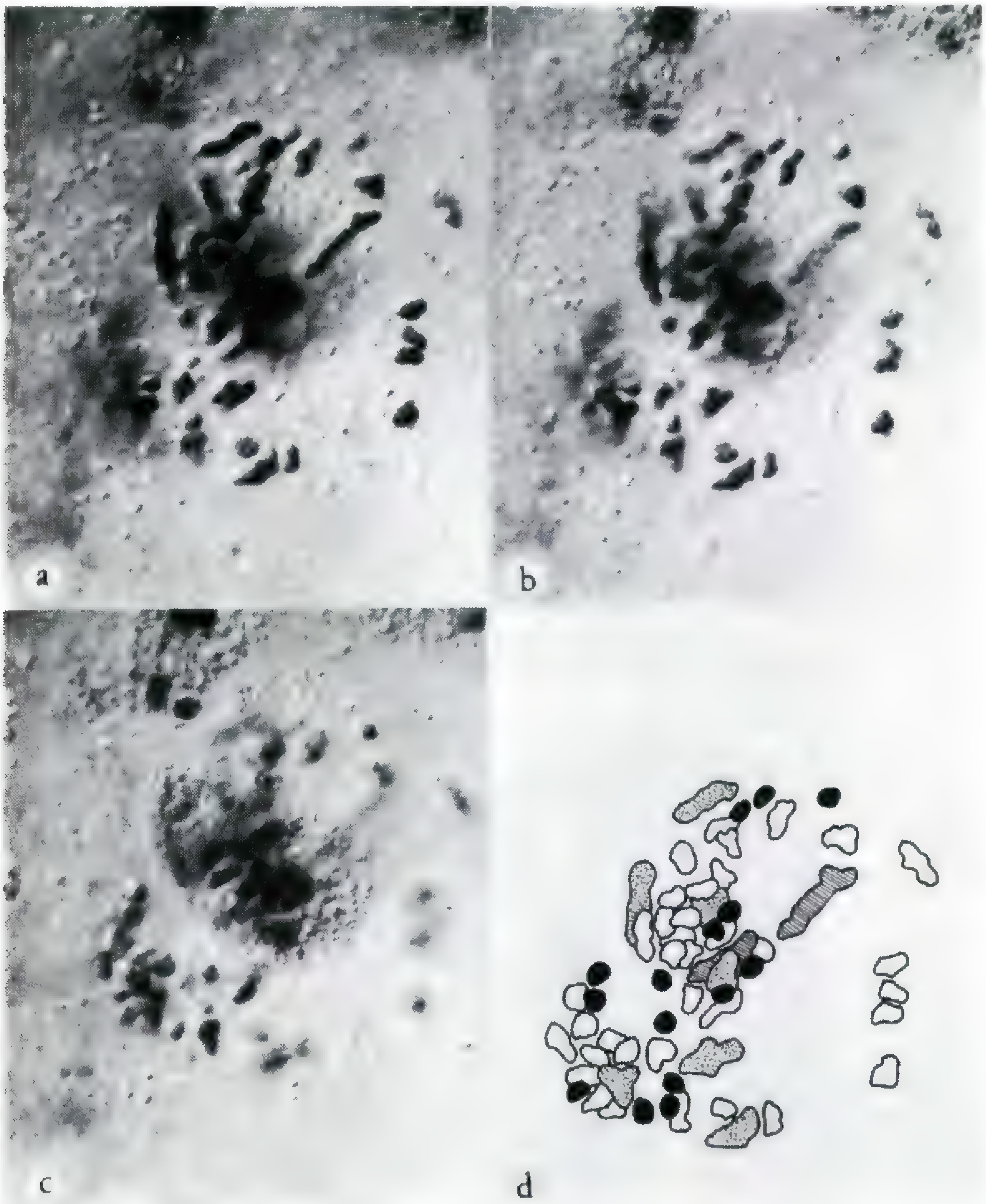


Figure 2. Spore mother cell from Type One sporangium of *Pellaea glabella* var. *glabella* (Laclede Co. material) at meiosis. × 2000. (Cell ruptured by pressure.) a, b, c: Cell photographed in three different focal planes. d: Explanatory diagram, Interpretation: Univalents (black) 15, Bivalents (white) 36, Trivalents (stippled) 7, Quadrivalents (hatched) 2.

Table 1.

Chromosomal association (univalent I to quadrivalent IV) frequencies in spore mother cells of Type One sporangia of *Pellaea*.

Taxon	Source of Material	I	II	III	IV
P. atropurpurea	Campbell's Bay, Quebec	20	20	9	
	Campbell's Bay	23	23	6	
	Fairmount Hotsprings, British Columbia	22	31	1	
P. glabella var. *glabella*	Rockwood, Ontario	34	20	10	3
	Rockwood	34	26	6	3
	Rockwood	39	18	11	2
	Rockwood	36	19	10	3
	Laclede Co., Missouri	26	32	6	2
	Laclede Co.	15	36	7	2

OBSERVATIONS

The chromosomes of the Type One spore mother cells tend to remain clumped together at meiosis and do not spread out well when squashed. Nine Type One cells were found that spread enough to be suitable for analysis, three from *P. atropurpurea* and six from *P. glabella* var. *glabella*. Photographs and explanatory diagrams of one cell from each of these taxa are shown in Figures 1 and 2, and the chromosomal association frequencies are summarized in Table 1. Even with the limited amount of material studied, it appears that in both taxa at least two thirds of the chromosomes are involved in some kind of association. Bivalents are more common than the higher order multivalents, but the relative frequencies of bivalents and univalents in the two samples of *P. glabella* var *glabella* differ; in the Rockwood material the univalents outnumber the bivalents, while in the material from Laclede County the proportions are reversed. In the Campbell's Bay material of *P. atropurpurea* the frequencies of univalents, bivalents and trivalents can be related to the basic chromosome number of 29, typical of the genus, but the material from Fairmount Hotsprings shows more than 29 associations.

DISCUSSION

Although the sample of Type One spore mother cells was not large enough for a meaningful statistical analysis, even within this small sample certain trends are indicated. In both species the proportions of different types of chromosomal associations show some variation from one population to another. In *P. atropurpurea* the material from Campbell's Bay suggests three sets of chromosomes, of which two sets possess a high degree of homology to each other, as shown by the formation of bivalents, while the third set has a lesser degree of homology to the other two, so that only about a quarter of its chromosomes go into the formation of trivalents, with the remainder being present as univalents. This type of chromosomal association might

indicate that *P. atropurpurea* arose from a cross between two distinct, though related species, one of which contributed two sets of chromosomes to the hybrid while the other contributed only one set. However, the cell from the Fairmount Hotsprings material, with its 31 bivalents, does not fit in with this pattern but rather suggests a more complex type of relationship.

In *P. glabella* var. *glabella* several probable quadrivalents were seen in the Type One spore mother cells from both populations, although their total proportion was low (about 10%). The presence of these quadrivalents suggests at least some homology among the four sets of chromosomes which originally contributed to the chromosome complement of this tetraploid. If quadrivalents, trivalents and bivalents are all cosidered, then on the average about 73% of the chromosomes in each cell are involved in some kind of chromosomal association, which again would suggest a fairly high degree of homology among these chromosome sets. This seems to indicate that *P. glabella* var. *glabella* originated either as an autopolyploid or from a cross between two closely related taxa. Because the species complex *P. glabella* includes two morphologically distinguishable, sexually reproducing diploid entities, namely var. *occidentalis* (E. Nelson) Butters, found in northwestern North America, and a diploid form of var. *glabella*, which so far has been reported only from Missouri (Wagner *et al.* 1965), possible ancestors for the tetraploid form of var. *glabella* can be found within the species complex.

While the patterns of choromosomal association observed in this study may suggest certain degrees of homology between the chromosome sets within each polyploid, it should be borne in mind that the degree of homology among the original sets of chromosomes of each polyploid may not be the only factor affecting chromosome pairing. Neither *P. atropurpurea* nor *P. glabella* var. *glabella* is a newly formed hybrid (or autopolyploid) but rather each has been reproducing asexually for many generations. During

this time changes may have taken place in the chromosome structure and in the genetic factors which govern chromosome pairing, so that the chromosomal associations seen at meiosis in the Type One spore mother cells are no longer fully indicative of the degree of homology between the chromosome sets involved. An indication that changes have taken place since these polyploids were first formed is the variation in chromosomal association frequencies between populations within each taxon. In fact, as Wagner (1963, 1970) points out, even in newly formed hybrids pairing may be influenced by genetic factors and therefore may not be a precise indicator of the degree of chromosome homology. The cytological observations made in this study cannot therefore be regarded as conclusive proof of the amount of homology between the various chromosome sets of the polyploids, but could serve as useful supporting evidence when used in conjunction with other types of observation, such as morphological characteristics.

SUMMARY

In obligately apogamous ferns the chromosome number is kept constant from generation to generation by a premeiotic doubling of the chromosome complement in some (but not all) of the spore mother cells, which then go through meiosis to produce viable spores. Spore mother cells in which such premeiotic doubling does not take place have irregular chromosome pairing at meiosis.

Pellaea atropurpurea is an apogamous triploid, while the most common form of *P. glabella* var. *glabella* is an apogamous tetraploid. In spore mother cells of these two polyploids — in which the chromosome number had not doubled when the chromosomes were observed at meiosis — univalents, bivalents and multivalents were all seen to be present. The patterns of chromosomal association observed could be interpreted as indicating homologies between the chromosome sets of the original parents of these polyploids, or they may be, at least in part, due to changes in chromosome structure and in the genetic factors governing

pairing that have taken place through many generations of asexual reproduction.

ACKNOWLEDGEMENTS

The author wishes to express her appreciation to Dr. D. M. Britton and Dr. Alice Tryon for their assistance and advice in this study. Financial assistance from the National Research Council of Canada, the Ontario Graduate Fellowship Program and the Ontario Department of University Affairs is gratefully acknowledged.

LITERATURE CITED

ALEXOPOULOS, C. J., & E. S. BENEKE. 1952. Laboratory manual for introductory mycology. Burgess Publishing Co., Minneapolis.

LU, B. C. 1967. The course of meiosis and centriole behavior during the ascus development of the ascomycete *Gelasinospora calospora*. Chromosoma 22: 210-226.

MANTON, I. 1950. Problems of cytology and evolution in the Pteridophyta. Cambridge Univ. Press, Cambridge.

RIGBY, S. J. 1968. An investigation of *Pellaea glabella* Mett. ex Kuhn and *Pellaea atropurpurea* (L.) Link and their relationships. Master's thesis. University of Guelph.

STEIL, W. N. 1919. A study of apogamy in *Nephrodium hirtipes* Hk. Ann. Bot. 33: 109-132.

TRYON, A. F. & D. M. BRITTON. 1958. Cytotaxonomic studies on the fern genus *Pellaea*. Evolution 12: 137-145.

WAGNER, W. H. JR. 1963. Biosystematics and taxonomic categories in lower vascular plants. Reg. Veg. 27: 63-71.

————————. 1970. Evolution of *Dryopteris* in relation to the Appalachians. pp. 147-192, *in* P. C. Holt (ed.), The distributional history of the biota of the southern Appalachians, Part II: Flora. Research Division Monograph 2, Virginia Polytechnic Institute and State University.

————————, D. R. FARRAR, & K. L. CHEN. 1965. A new sexual form of *Pellaea glabella* from Missouri. Am. Fern Jour. 55: 171-178.

DEPARTMENT OF BOTANY AND GENETICS
UNIVERSITY OF GUELPH
GUELPH, ONTARIO, CANADA

THE PAST AND PRESENT GEOGRAPHICAL DISTRIBUTION OF PETALOSTEMON FOLIOSUS AND NOTES ON ITS ECOLOGY

JERRY M. BASKIN AND CAROL C. BASKIN

Petalostemon foliosus Gray, a member of the Leguminosae, is a rare plant species that now appears to be restricted to a few localities in central Tennessee and northern Alabama. However, at one time it also occurred in at least four counties (LaSalle, Kankakee, Kane and Will) in northeastern Illinois. Herbarium specimens from these Illinois counties have been cited by Gambile (1953) and (or) Wemple (1965), and specimens are still present in various herbaria (F, GH, ISC, US, NY and ILL). Among the collections in these herbaria the latest one is dated 12 September 1912 (*L. M. Umbach* 5715, in the Iowa State University Herbarium, collected from river flats, Romeo, Will County, Illinois). This may possibly represent the last collection of *P. foliosus* in Illinois. Jones (1963) and Wemple (1965, 1970) state that the species probably is now extinct in Illinois.

Although the species has persisted until the present in several localities in central Tennessee and in at least two locations in northern Alabama, it has not been collected widely and, therefore, very little is known about its distribution in central Tennessee and northern Alabama. In a recent revision of the genus, Wemple (1965) cites specimens from Davidson, Franklin and Rutherford Counties in middle Tennessee and from Knox County in east Tennessee. All of the specimens that he examined from middle Tennessee were collected since about 1915, from a cedar glade area across from Stones River Park, 2 miles northwest of Murfreesboro, Rutherford County, Tennessee. Sharp *et al.* (1960) list the species as occurring in Davidson and Rutherford Counties in central Tennessee and Mahler (1970) lists it from the same two counties and

from Knox County in east Tennessee. Baskin and Caudle (1967) first reported the species from Alabama, in Franklin and Morgan Counties.

While making botanical observations in central Tennessee, we have found the species in several counties where it previously has not been reported. These counties include: Wilson County, Cedars of Lebanon State Forest, 6 August 1971 (*Baskin & Baskin* 1177); Maury County, 2.7 miles east of Columbia on Co. Rd. 50, 23 August 1966 (*Baskin & Caudle* 522); Marshall County, 1 mile east of U. S. 431 on St. Rd. 99, 18 August 1970 (*Baskin & Baskin* 869). In addition, there is a specimen from Williamson County, Tennessee in the Vanderbilt University herbarium (VDB) from along Sneed Road west of Hillsboro Avenue toward the Harpeth River (*Kral* 29001). Actually, this population was discovered earlier by Dr. Elsie Quarterman of Vanderbilt University, but apparently she did not place a specimen in the herbarium at Vanderbilt.

During August 1971, we visited the previously known locations of *P. foliosus* in Franklin and Morgan Counties Alabama, and Marshall, Maury, Williamson and Wilson Counties Tennessee to see if the species was still present in these locations. In all the locations visited we found at least a few plants of the species. From our recent observations on living populations of the species and from available specimens and literature, we have constructed a map of the known past and present geographical distribution of the species (Fig. 1). Although we do not know of specific locations for *P. foliosus* in Rutherford County, Tennessee, at least two collections were made there in the 1960's. One, *L. E. Franklin & J. D. Freeman* 2481, on 26 July 1962 (VDB), and the other, *D. Isley & D. Wemple* 9420, on 11 September 1964 (ISC). Although there have not been any recent colleetions of *P. foliosus* in Davidson and Franklin Counties, Tennessee, there is no reason to believe that the species is not present there because seemingly suitable cedar glade habitats are available, and the species does occur in nearby counties.

Fig.1. Past and present geographical distribution of *Petalostemon foliosus*.

The occurrence of *P. foliosus* on the "U. T. Farm" in Knox County, Tennessee is represented on the distribution map; it probably was transplanted to that site and no longer survives there. The only specimen that seems to have been collected from this location is 20 September 1938, Lahner (TENN). Sharp *et al.* (1960) do not cite this location.

Gleason (1952) and Gleason and Cronquist (1963) also give the species as occurring in Ohio, but its occurrence there is doubtful. None of the other literature that we examined refers to any specimens collected in Ohio, and Weishaupt (1968) does not include the species in her *Vascular Plants of Ohio.*

The habitat and distribution of *P. foliosus* have been described in various taxonomic and floristic works as follows: river banks, Interior Low Plateau, Tennessee to Illinois (Small, 1933); rocky hills, glades and river banks, northern Illinois to Tennessee (Fernald, 1950); river banks, Illinois, Ohio and Tennessee (Gleason, 1952; Gleason and Cronquist, 1963); river banks and gravelly soil, rare or probably now extinct in Illinois (Jones, 1963) and cedar glades, barrens, Tennessee, northern Illinois and Alabama (Mahler, 1970).

In central Tennessee and northern Alabama *P. foliosus* always is associated closely with cedar glades. On the typical Lebanon limestone glades (for description see Quarterman, 1950), *P. foliosus* usually occurs at the edges of open glades in the transition zone between open glades and glade thickets or woods, a habitat that is shaded during at least part of the day. In this situation *P. foliosus* often is associated with *Astragalus tennesseensis* Gray, *Asclepias verticillata* L. and *Sporobolus vaginiflorus* (Torr.) Wood. In one glade in Marshall County, Tennessee that is more prairie-like than typical Lebanon limestone glades, *P. foliosus* occurs in an opening that receives full daylight throughout the growing season, as well as near a shrub thicket composed of *Symphoricarpos orbiculatus* Moench, *Rhus aromatica* Ait. and *Forestiera ligustrina* (Michx.)

Poir. The open, prairie-like portions of this glade, where *P. foliosus* grows, are dominated by *Panicum capillare* L. Here a layer of mineral soil (30-45 cm deep) overlies solid bedrock. Other plants on this glade with prairie affinities include *Cacalia tuberosa* Nutt., *Helenium autumnale* L. and *Desmanthus illinoensis* (Michx.) MacM. *Petalostemon foliosus* grows in a somewhat similar open, prairie-like situation in Morgan County, Alabama and Williamson County, Tennessee. In Morgan County, Alabama its most frequent associates are *Cassia fasciculata* Michx., *Rudbeckia triloba* L. and *R. hirta* L., and in the glade in Williamson County, Tennessee *Astragalus tennesseensis* and *Delphinium virescens* Nutt. are frequent associates.

Since apparently very little is known about the ecological life cycle of *P. foliosus*, we believe that it is not inappropriate to report here our observations on the phenology of this species in the field. In March new buds located at or slightly below the soil surface at the base of the previous year's growth (shoot) begin growth. By early June the new shoot is 15-20 cm tall. Growth of the shoot in height continues until July by which time plants are typically 40-65 cm tall. An individual plant usually bears one shoot with many inflorescences, but some plants may have several shoots with many inflorescences each. Flower buds apparently are formed in late June or early July and by mid-July large flower buds are visible. Flowering begins in late July or early August and continues through August. The peak of flowering is approximately mid-August. The only insect that we have observed visiting the flowers of this species is a bumblebee (*Bombus* sp.). By early October seeds are ripe and by mid-October the shoots are dead. However, after the shoots die they remain erect and hold the fruiting heads into the winter. Seeds are not shed immediately upon ripening but are dispersed from the plants from late fall to early spring. Our observations indicate that seed set is good.

Germination in the field occurs in April and by late May the seedlings have several leaves. Numerous seedlings of

P. foliosus were present in the Morgan County, Alabama population on 6 April 1972. These seedlings were in the cotyledon or first leaf stage. As in many members of the Leguminosae (Crocker and Barton, 1953), seed coats of most of the freshly-matured seeds of *P. foliosus* are impermeable to water, but will germinate to nearly 100% when mechanically scarified. However, in nature the seed coat must be softened by natural agents before the seeds can germinate. All the seeds produced in a particular seed crop do not soften by the following spring, and it takes several years for the coats of all seeds in a particular crop to soften. We planted 400 seeds on greenhouse potting soil in flats on 11 October 1969 and placed them on a bench in a non-heated room of a greenhouse at the University of Kentucky. Eleven of the seeds germinated during the fall of 1969, indicating that only a very small percentage of the freshly-matured seeds had permeable or soft coats. After overwintering in the greenhouse, 21 additional seeds germinated in the spring of 1970, and to date after three overwinterings) only 89 of the seeds have germinated. During the spring of 1970 most of the germination in the non-heated room of the greenhouse occurred between 8 April and 6 May when the average daily maximum and minimum temperatures in the greenhouse were 23.7 and 11.3°C, respectively. During the spring of 1971 most of the germination occurred bewteen 1 April and 20 April when the average daily maximum and minimum temperatures in the greenhouse were 23.6 and 8.3°C, respectively.

It appears that very few of the seedlings survive to maturity as relatively very few juvenile plants can be found in the field in the summer and fall. Our observations indicate that seedlings are drought intolerant and that many of them are killed by summer drought. We observed dead seedlings during a short dry period in late May of 1971 and others that were badly wilted. Since the species does not reproduce vegetatively and since very few seedlings survive, perennation is a most important factor in maintaining populations of this species. Further evidence that

suggests that seedling survival is poor is that the number of plants in the small populations of this species does not seem to be increasing. For example, in the populations of *P. foliosus* in Franklin County, Alabama and in Maury County, Tennessee where the populations consist of less than 25 plants each, there was no noticeable change in number of plants between 1966 when we first discovered the populations and 1971 when we last observed them.

Petalostemon foliosus is a rare and "endangered" species. Although one of the populations (Morgan County, Alabama) consists of hundreds of individual plants and another one (Williamson County, Tennessee) has several dozen plants in it, all the other populations that we have seen have less than 25 plants. As we have mentioned in a previous article on *Astragalus tennesseensis* (Baskin, Baskin and Quarterman, 1972), another rare cedar glade endemic, the glade habitats in middle Tennessee rapidly are being destroyed or disturbed. Some of the glade habitats that have been destroyed once supported populations of *P. foliosus.* For example, until 1967 there was a sizeable population of *P. foliosus* on a glade 2 miles northwest of Murfreesboro in Rutherford County, Tenn. In 1967 this area was bulldozed in preparation for construction of a box factory and, of course, the entire population was destroyed.

Both the Morgan and Franklin County populations of *P. foliosus* are in a precarious position as is true for the one population of *Astragalus tennesseensis* that we know of in Alabama. The large population, in Morgan County, is located mostly along side a narrow, gravel road and if the road is widened to any extent most, if not all, of this population will be destroyed. The population of *P. foliosus* in Franklin County, Alabama is located on the right-of-way of County Road 79 and should this two lane road be widened this small population (17 plants in 1971) will undoubtedly be destroyed.

The past and present geographical distribution of *P. foliosus* and *A. tennesseensis* are very similar. Both species

once had two centers of distribution; one in middle Tennessee and northern Alabama and another in northern Illinois. Both apparently have become extinct in Illinois and now are restricted to middle Tennessee and northern Alabama. Undoubtedly habitat destruction in the present geographical range of these two species will continue with obvious consequences. It seems reasonable to predict, then, that the two species will become extremely rare and maybe even extinct in this century.

Travel funds for this project were provided by a grant from the University of Kentucky Research Committee. This support is gratefully acknowledged.

LITERATURE CITED

BASKIN, J. M. and C. CAUDLE. 1967. *Petalostemon foliosus* in Alabama. Rhodora **69**: 383-384.

BASKIN, C. C., J. M. BASKIN and E. QUARTERMAN. 1972. Observations on the ecology of *Astragalus tennesseensis*. Amer. Midl. Natur. **88**: 167-182.

CROCKER, W. and L. V. BARTON. 1953. Physiology of seeds. Chronica Botanica Company, Waltham, Mass. 267 pp.

FERNALD, M. L. 1950. 8th Ed. Gray's manual of botany. Amer. Book. Co., New York. 1632 pp.

GAMBLE, W. G., JR. 1953. The Leguminosae of Illinois. Illinois Biological Monographs. Vol. XXII, No. 4. The University of Illinois Press, Urbana. 117 pp.

GLEASON, H. A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. The New York Botanical Garden. Lancaster Press, Inc., Lancaster, Penn. Vol. III. 589 pp.

——— and A. CRONQUIST. 1963. Manual of the vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand Comp., Inc., Princeton, N. J. 810 pp.

JONES, G. N. 1963. Flora of Illinois. 3rd Ed., The American Midland Naturalist Monograph No. 7. The University of Notre Dame Press, Notre Dame, Indiana. 401 pp.

MAHLER, W. F. 1970. Manual of the legumes of Tennessee. Jour. Tenn. Acad. Sci. **45**: 65-96.

QUARTERMAN, E. 1950. Major plant communities of Tennessee cedar glades. Ecology **31**: 234-254.

SHARP, A. J., R. E. SHANKS, H. L. SHERMAN and D. H. NORRIS. 1960. A preliminary checklist of dicots of Tennessee. ms.

SMALL, J. K. 1933. Manual of the southeastern flora. University of N. C. Press, Chapel Hill. 1554 pp.
WEISHAUPT, C. G. 1968. Vascular plants of Ohio (Revised Edition). Wm. C. Brown Book Co., Dubuque, Iowa. 280 pp.
WEMPLE, D. K. 1965. Revision of the genus *Petalostemon* (Leguminosae). Ph.D. Thesis, Iowa State University (Libr. Congr. Card No. Mic. 66-3015). 321 pp. Univ. Microfilms. Ann Arbor, Mich.
————. 1970. Revision of the genus *Petalostemon* (Leguminosae). Iowa St. Jour. Sci. 45: 1-102.

DEPARTMENT OF BOTANY
UNIVERSITY OF KENTUCKY
LEXINGTON, KENTUCKY 40506

BOOK REVIEW

FLORA OF THE GALÁPAGOS ISLANDS[1]

This splendid volume was published in 1971. The first copies to reach the Galápagos Islands were brought there in June of that year by Dr. William A. Weber. In the interesting review that later appeared under his name in Science (1972) he explained that he was able to test the book on location with the first study tour conducted there for university credit.

Quite by chance the present reviewer was privileged to make a similar test of the book in June and July of that same year. With my wife, I arrived at Baltra Island in the Galápagos on June 22, 1971 to take the two weeks' cruise on the "Golden Cachalot" under Lindblad auspices. The first day out the owner, Mr. David Balfour, learning that I was a botanist, placed an unused copy of the book now under review in my hands whereupon the excursion became not only a most pleasant experience in natural history but an education in Galápagos botany. The copy of the

[1]WIGGINS, IRA L. and DUNCAN M. PORTER. 1971. Stanford University Press, Stanford, California. XVII, 998 pp. + plates. $37.50.

Galápagos *Flora* I used may have been one brought by Dr. Weber, but if it were not, it must have reached there about the same time. I can lay claim to being the first "tourist" to have made extended use of the *Flora* in understanding the plants of the Galápagos.

The *Flora of the Galápagos Islands* became a focus of attention during many relaxed moments on that memorable cruise among the islands. Specimens were brought back from journeys ashore by enthusiastic fellow tourists and the very helpful staff were much interested in increasing their considerable stores of knowledge of the plant life of the islands. Mr. Balfour in particular supported my endeavors by supplying a small plant press and, from time to time, bringing back some exceptionally interesting specimens to put in it.

It should be emphasized that the islands have been set aside as a National Park by Ecuador. Collecting therefore had to be limited to fragments of plants or to few specimens in the case of abundant species. For ready identification more complete specimens would have been more suitable. Surprisingly, late June and early July, 1971, proved to be somewhat cool and moist with occasional showers even at sea level. Therefore, the drying of plants was helped greatly by putting the press in a compartment above the engine room.

In view of the fact that I had made no plans to carry on any botanical work at all and that I had no knowledge, on reaching the Galápagos Islands, that a *Flora* of it had even been thought of, it is interesting to record that some 120 species of vascular plants were collected and most of these were identified during the cruise. More than 40 of the 120 proved to be endemics which is a higher proportion than the 32% endemism recorded by Wiggins and Porter for the entire vascular flora. Probably at least 100 other species were identified but not collected during the cruise. This speaks well for the usefulness of the book to a botanist who had no previous acquaintance with this or floras of similar tropical areas. Since the known Galápagos

flora consists of 642 species it was possible to attain some familiarity with nearly one third of the species of the islands. Had this book not been available with its workable keys, abundant and clear illustrations, detailed maps and range data, good descriptions as well as the helpful discussions of the plants of the several vegetational zones, hardly a beginning could have been made.

It was pointed out by Wiggins and Porter in their introduction on pp. 29 and 30 that much more field work needs to be carried on in the higher parts of the islands comprising the SCALESIA, MICONIA and FERN-SEDGE zones. They conclude (p. 30) with this statement, "There undoubtedly are many niches that have not yet been seen or recorded: Isabella especially, owing to its great area, is only minimally known." Weber (1972, p. 290) makes this assertion after having used the book in the islands during his visit in June 1971, "The strongest impression I have from the experience is that the book is still a preliminary treatment. The islands will not be adequately known until there are resident botanists studying the flora and until the Darwin Research Station is equipped for the handling, drying and proper storage of botanical materials." At the Darwin Station on Santa Cruz Island on July 3, I talked with Daniel Weber who had assembled a neat collection of about 1000 specimens. He had collected in difficult parts of the islands and told me of many new stations to add to those in the *Flora*. Specifically he stated that he had found *Pernettya Howellii* in two localities on Isabella Island, whereas Wiggins and Porter reported this endemic species only from Santa Cruz Island. My own limited experience convinces me also that the *Flora of the Galápagos Islands* for all its excellence and thoroughness, is but a beginning. On Santa Maria in a tidal pool near a much visited lagoon hardly off the beaten track I found *Ruppia maritima* in abundance. Daniel Weber did not know of this station and Wiggins and Porter state of the species (p. 928) ". . . known only from Isabella and Genovesa, but to be expected elsewhere."

Very recently Johnson and Raven (1973) have made extensive use of information extracted from the *Flora* about the numbers of species, percentage of endemism, etc., in relation to area of the different islands and in relation to the vegetational zones where endemics and other species are found. They point out that almost all other islands which have been studied in detail have a high degree of endemism in the moist uplands, whereas in the Galápagos the degree of endemism in the moist uplands is low. They fail to make entirely clear what they mean by moist uplands for, according to Wiggins and Porter, the heaviest rainfall in the Galápagos Islands falls in the altitudinal zone dominated by *Scalesia* forest between 180 and about 400 m elevation on southern slopes and 300 to 500 m on northern slopes. The considerable areas above this zone receive less rainfall than the *Scalesia* forest. Johnson and Raven (loc. cit. p. 895) state that Colinvaux in a paper in press "has shown that the period from about 10,000 to 30,000 years ago (radiocarbon dates) was very much drier than the present. In the light of his findings we propose that the great majority of the nonendemic plants in the moist uplands have reached the Galápagos Archipelago within the past 10,000 years. Moist uplands in their present form seem to have existed in the Archipelago only during this period of time." If by moist uplands Johnson and Raven include the *Scalesia* forests which presumably they do, they should advance some explanation for the evolution of a modified rain forest situation dominated by several species of the endemic genus *Scalesia*, the endemic *Psidium galapageium* and another endemic, *Pisonia floribunda*, the two last named of which grew to a size and in numbers sufficient to be shipped from the Galápagos to the mainland as lumber in earlier times. Presumably this type of forest or at least the species which comprise it must have been in the process of evolution ostensibly under reasonably moist conditions for more than 10,000 years. It seems a bit early to make sweeping generalizations about the time of arrival of the floras in the several zones and to

extrapolate from the meager data yet available. Above the *Scalesia* zone and intermingling with the fern-sedge vegetation of the highest parts of the islands there is a dominance of *Miconia Robinsoniana* and above this, amongst the low and dense fern-sedge type of vegetation on several of the larger islands, the very beautiful tree fern, *Cyathea Weatherbyana* is found. The former was named in honor of Benjamin Lincoln Robinson, the first editor of Rhodora who prepared the first Galápagos flora while the latter honors the distinguished specialist on ferns, Charles A. Weatherby. It was particularly interesting to me to observe these species growing side by side with the familiar *Lycopodium clavatum* and *Pteridium aquilinum* nearby. The presence of the endemic *Miconia* and *Cyathea* would seem to depend on reasonably moist conditions having obtained for some time in the areas where they are not growing or in places not far away. It is also entirely probable that the amount of speciation that has taken place in a flora may not be a very good indication of the age of the flora. This is not to say that the upper levels of these islands *may not* have received most of their species in recent times. Further exploration in these neglected parts of the islands is urged by Wiggins and Porter. The percentage of endemism may still prove to be low when these areas are carefully studied. What the Galápagos really need most is plenty of study and not too many guesses.

Whatever may be our eventual understanding of the phytogeography of these extraordinary islands, the Wiggins and Porter *Flora* stands as a magnificent base for future work. It is a sumptuous work, attractive to peruse, with its 16 pages including 96 individual photographs in color of scenic features, vegetation and individual plants. There is an introduction or preliminary discussion of the geography, physiography, geology, climate, human history, soils, vegetational zones, history of botanical work on the islands and several pages devoted to fauna. There follows the main body of the work arranged in the following order: Ferns and Relatives, Apetalae, Gamopetalae, Polypetalae,

and finally Monocotyledons. The families, genera and species are arranged alphabetically within these 5 larger groupings. Many families and genera of the main body of the book were done by specialists and, as one might expect, the treatments are somewhat uneven though presumably all are scholarly. Some groups are amply illustrated while others such as *Mollugo* would have benefited by more pictures. A few errors were noted. Some of the obvious ones were pointed out by Weber in his review in Science.

While the foregoing remarks may seem often to be peripheral to the intended theme — a review of the *Flora of the Galápagos Islands* — the comments are all occasioned directly or indirectly by my use of the book. This reviewer is probably prejudiced but he can think of no book in recent years that has given him more pleasure in the using.

LITERATURE CITED

JOHNSON, MICHAEL P. and PETER H. RAVEN. 1973. Science 179: 893-895.

WEBER, WILLIAM E. 1972. Science: 175: 290-291.

A. R. HODGDON
DEPARTMENT OF BOTANY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, N.H. 03824

UMALDY T. WATERFALL (1910-1971)

U. T. Waterfall was born in Frederick, Oklahoma on August 13, 1910 and died in Stillwater, Oklahoma on October 27, 1971. He married La Clida Cotter, July 24, 1935 at Fairfield, Oklahoma. He is survived by his wife and three children. Dr. Waterfall received his public school education at Albion, Oklahoma where he graduated from high school in 1931. He attended Arkansas Tech at Russelville, Arkansas for two years and received a B.S. from Oklahoma A & M (now Oklahoma State University) in Stillwater in 1935. He studied botany at the University of Oklahoma, Norman, and received his M.S. in 1942 and Ph.D. in 1956. His doctoral dissertation was a monographic treatment of the genus *Physalis* (Solanaceae) from which numerous papers have appeared in print.

U. T. Waterfall held memberships in several professional organizations including: Southwestern Association of Naturalists (served as president in 1965), International Society of Plant Taxonomists, American Society of Plant Taxonomists, New England Botanical Club, Oklahoma Academy of Sciences (served as section editor until his death), Phi Kappa Phi, and Sigma Xi. In addition, he is listed in "Who's Who in the South and Southwest", "Leaders in American Science", and "World Who's Who in Science."

Dr. Waterfall began his teaching career in 1934 at Helena High School, moving to Central High School in Oklahoma City in 1936. His first five years at Central High School were spent teaching music. However, after receiving his M.S. in 1942, he changed to teaching science. In 1944, he left the teaching field for two years and worked as a range ecologist with the Soil Conservation Service. In the fall of 1946 he accepted an instructorship to teach botany at the University of Oklahoma. He joined the faculty at Oklahoma State University in 1949 where he remained until his death. During his earlier years at OSU, he commuted to the University at Norman while working toward his Ph.D. Besides his regular duties as classroom teacher

and curator, Dr. Waterfall served on graduate committees of numerous students from botany and biological sciences to zoology, wildlife, agronomy and education. Additionally, he supervised the research of several masters degree candidates as well as six doctoral candidates. I was the last student to receive the Ph.D. under the direction of U. T. Waterfall, and consider myself fortunate to have been influenced by his knowledge and experience.

U. T. Waterfall's first publication was the result of numerous collecting trips to various parts of Oklahoma prior to 1939. Study of the state flora continued until his death, resulting in over 30 papers. Most of these appeared in "Rhodora" and "The Proceedings of the Oklahoma Academy of Science", others in "Sida", "Field and Lab" and "Southwestern Naturalist". Some of the more recent papers have been published under the title "Studies in the Composition and Distribution of the Oklahoma Flora". In 1952, "A Catalogue of the Flora of Oklahoma" was prepared by Dr. Waterfall and published by the Oklahoma Research Foundation. It listed 2542 taxa of specific or infraspecific status. Immediately following this work, he began his long study of all the vascular plants of the state. Parts of this study were finished and made available to his plant taxonomy classes in 1953, 1955, 1957, 1958, and 1959. These early works comprised his 1st edition, "Keys to the Flora of Oklahoma." The Keys . . ." has been revised periodically and is now in the 4th edition.

In accordance with an original plan, Dr. Waterfall was, for over twenty years, expanding the "Keys . . ." into a flora of the state. He died before this work was finished. Because of the nature of the work and the difficulty of typing the manuscript he typed over 700 pages of this later work himself. It is the desire of all who knew him that this work will not go unfinished.

In 1965 Dr. Waterfall received a grant awarded by the National Science Foundation to study collections of *Physalis* from Mexico, Central America and the West Indies which are housed in the great European herbaria. This

study was published in "Rhodora" in 1967. Because of this and earlier treatments of *Physalis*, Waterfall is widely acclaimed as the foremost authority on this difficult genus.

In addition to his European travels, Dr. Waterfall made several extended collecting trips in the United States and Mexico. His first collecting trip outside Oklahoma was to the various national forests of Colorado, Wyoming and Utah, but he did little with these collections because his interests turned to the Mexican flora and the flora of the desert Southwest. During the early years of World War II, he spent three summers studying poisonous plants along the Texas-Mexico border for Harvard University. Other valuable collections from "Southwestern Texas" are in the OSU Herbarium as well as other large herbaria in the United States.

Dr. Waterfall made four trips into Mexico. In a letter from his wife (November 26, 1972), she stated: "I think we must have traveled every road and trail north of Mexico City — as well as many places where we made our own trails!" A fifth trip was started in 1967 but had to be terminated at Laredo, Texas due to his health. From these trips, Dr. Waterfall collected some 5,000 sheets which have been distributed to various United States herbaria. The originals are in a separate "Mexican Herbarium" at OSU. Several new species and one new genus have been described by Dr. Waterfall as a result of these four collecting trips into Mexico.

During the last ten years of his life, his major problem was his health. During that period he had 5 major operations, 2 heart attacks, and several bouts with serious kidney infections. After an extended illness, he died on October 27, 1971 in the Stillwater Municipal Hospital.

In addition to his study of Oklahoma plants, some of his more noteworthy works include:

Waterfall, U. T., 1951. The Genus Callirhöe (Malvaceae) in Texas. Field and Lab. **19** (3): 107-119.

————. 1958. A Taxonomic Study of the Genus *Phy-*

salis in North America North of Mexico. Rhodora **60**: 107-114; 128-142; 152-173.

————. 1959. *Separotheca,* A new Genus (Commelinaceae) from Mexico. Rhodora **61** (725): 136-139.

Waterfall, U. T., and Mahler, W. F., 1964. *Baccharis* (Compositae) in Oklahoma, Texas and New Mexico. Southwestern Naturalist **9** (3): 189-202.

Waterfall, U. T., 1967. *Physalis* in Mexico, Central America and the West Indies. Rhodora **69**: 82-120; 203-239; 319-329.

JACK W. STANFORD
HOWARD PAYNE COLLEGE
BROWNWOOD, TEXAS 76801

THE ENVIRONMENT OF SCHISTOSTEGA PENNATI (HEDW.) HOOK. & TAYL.: NEW VERMONT STATIONS

DONOVAN R. BOWLEY[1]

Schistostega pennati is the sole member of the moss family Schistostegaceae. It has attracted attention over the years primarily because of its characteristic of reflecting light back out of the crevices it grows in, with a chatoyant green-gold glow. Every six or eight years someone reports a new station, ranging in size from pea-sized patches to the magnificent expanse of several yards under the barn at Oldfields, in Groton, New Hampshire (Thomson, 1956). In most of the literature it will be found under *S. osmundacea* (Dicks.) Mohr. Most often it is discovered as a glowing mass of protonema on damp soil or rock in some dark crevice. Occasionally fertile and sterile fronds

[1]Biology Department, Boston University, Boston 02116. This note is on part of the work done under NDEA Title IV Fellowship number 02022.

are found as well, looking like diminutive ferns of the genus *Osmunda*. Grout (1935) gives a concise description of the plant. Marshal (1920) has a good description and several drawings.

This plant is apparently circumboreal and tolerates a wide range of conditions. J. S. Erskine (1950) found it on slate a few yards from an arm of Halifax Harbour, N.S. D. S. Johnson (1925) found a maritime station at Mt. Desert Island, Maine. Here, the moss grew three or four feet above the high tide within the range of the salt spray, and in fact, on some *Fucus* that had washed into its cranny. In this particular station, the only light it received was that reflected into its cavern from the surface of the ocean. Schofield (1969) reported it "in shallow caverns, and on the raw earth of overturned tree roots in swampy parts of cedar-hemlock forests."

Early information suggested it was a calciphobe, but Grout (1933) found it in a crevice of a limestone cliff in a quarry. At this station, it was growing "in the open" in a crevice of a north-facing cliff.

The more typical site is that described by Grout (1899, 1902a, 1902b, 1906), Kaiser (1921), and Nichols (1933). Each of these sites is a moist crevice, usually in the back of a larger cavern or hole; or a moist cellar under a shed or a barn. Champlin (1969) found it inside the entrance to a graphite mine in Rhode Island.

It appears that in nearly every case the moss is located on a condensing surface, rather than where water is actively flowing. Johnson (1925) reported that the moss in the seaside station in Maine obtained its water from condensation on the cooler rock, of fog, or of water evaporated from the surface of the ocean.

A review article by J. M. Coulter (1918) of the work in Japan of Viscount Toda reveals some interesting notes on the physiology of the moss. The protonema can live seven months in culture without producing a leafy shoot. "Chromatophores" scatter in a day and change direction of orientation in seven to ten days. Spores germinate in

one month at 60-77°F. The leafy shoot dies at about 0°F; the protonema survives to –5°F. The optimum temperature for the leafy shoot is 60-77°F. Gistl (1926) reports lens-like cells in the protonema, which focus light within the cell. At the focus of the light are located the chloroplasts. This cell develops best when subjected to unidirectional light. He cultured *Schistostega* for three years in the laboratory and found that under optimum conditions the position of the chloroplasts could change in from one to three hours.

So we have in this small plant an adaptation to low levels of unidirectional light, giving it a competitive edge in those situations. The readjustment to changes in light is rapid, and would enable it to survive in areas where its caverns under rocks and tree roots were shifted by storm or wind. As evidenced by its growing on raw earth in the open in British Columbia (Schofield, 1969), on the cliff where Grout found it (1933), and in full sunlight in Gistl's laboratory (1926), it can survive in the open. It is most likely an early colonizer in humid, cool locations, but is rapidly overgrown by heartier vegetation, and survives in the hollows and crevices where the other plants cannot follow.

During the summer of 1969 several new stations for the luminous moss were discovered by Duncan Galbraith of Essex Junction, Vermont, and by the author. Two more stations were discovered in the summer of 1971 by Ranger-guide Kenn Boyd of Burlington, Vermont. All of the stations are mid-talus slope on the east side of Mt. Mansfield, Vermont. All are within half a mile of Cliff House (top station of the Gondola lift). Grout (1906) reported similar stations on the "Nose" cliffs of Mt. Mansfield.

One station near Cliff House was observed through the winter of 1969-1970. Ground heat and warmer air rising through the talus from below passed through the crevice, melting all the snow out of the crevice and from in front of the opening of the rocks. A small hole opened through to the "outside world". As the temperature of the outside

air rose, the opening became larger. As the outside air temperature fell, rime ice formed around the rim of the opening, closing it down — in effect, a natural thermostat. Measurements on a Taylor maximum-minimum thermometer suspended through the hole on a string showed a nearly constant internal temperature of 35°F, ±1°F, while the outside temperature varied through a 31°F range. In addition, the thin shell of snow that remained over the hollow acted as a sort of "greenhouse roof", allowing light to pass through.

In summer, the temperatures of his "moss-hole" were lower than that of the surrounding woods because of cool, moist air draining down out of the talus above. Both summer and winter there was a slight excurrent of moist air.

LITERATURE CITED

British Bryological Society. 1946. "Annual meeting of the British Bryological Society, 1946." Bryologist **49:** 99.

Campbell, Douglas H. 1918. The structure and development of mosses and ferns, 3rd edition. Macmillan Company, New York.

Champlin, R. L. 1969. "A Rhode Island station for luminous moss." Rhodora **71:** 305.

Conard, Henry S. 1938. "The foray in upper Michigan, 1937." Bryologist **41:** 20.

Coulter, J. M. 1918. Review in Bot. Gaz. **67:** 278-279.

Erskine, J. S. 1950. "More minute mosses from Nova Scotia." Bryologist **53:** 54-56.

Gistl, R. 1926. "Bezichung zwischen licht und Schistostega-vorkeim." Ber. d. Deut. Bot. Ges. **44:** 483-492.

Grout, A. J. 1899. "An annotated list of rare or otherwise interesting mosses occurring in or near Plymouth, New Hampshire." Rhodora **1:** 54.

——— 1902a. "A new habitat for *Schistostega.*" Bryologist **5:** 103.

——— 1902b. "Notes on Vermont Mosses." Rhodora **4:** 182.

——— 1906. "Notes on Vermont Bryophytes — 1906." Bryologist **10:** 6, 7.

——— 1933. "Miscellaneous notes on mosses." Bryologist **36:** 25.

——— 1935. Moss flora of North America. vol. 2, part 2. By the author. Newfane, Vermont.

——————— 1940. "Moss notes, 1940." Bryologist **43:** 75.

HUNTINGTON, J. W. 1902. "How I found *Schistostega osmundacea.*" Bryologist **5:** 52.

JOHNSON, D. S. 1925. "A maritime station for *Schistostega osmundacea.*" Bryologist **29:** 18-19.

KAISER, G. B. 1921. "Little journeys into moss-land. IV — the luminous moss." Bryologist **24:** 48.

MARSHALL, N. L. 1920. Mosses and lichens. Doubleday, Page, and Co. pp. 199-202.

NICHOLS, G. E. 1933. "Notes on Michigan bryophytes — II" Bryologist **36:** 75.

SCHOFIELD, W. B. 1969. "Some common mosses of British Columbia." British Columbia Provincial Museum, Handbook No. 28.

THOMSON, J. W. 1956. The 1956 foray of the American Bryological Society." Bryologist **60:** 41.

A NEW STATION FOR *SAXIFRAGA RIVULARIS* L. IN THE WHITE MOUNTAINS, NEW HAMPSHIRE

On June 18, 1969 Dr. Rosemary Mackay of Montreal drew my attention to a small group of plants growing at the southwest corner of the Appalachian Mountain Club Lake-of-the-Clouds Hut located at 5,000 ft. on the slope of Mt. Washington (Fig. 1). The plants were *Saxifraga rivularis* L. primarily known in recent years from a small station on the summit of Mt. Washington at 6,288 ft. (Pease, 1964). The identification was confirmed by the late Dr. Stuart K. Harris of Boston University. A specimen has been deposited in the herbarium of the University of New Hampshire.

The station includes about 15 plants growing in a compact group. Most plants were in flower on June 18, and by July 3, 1969 most had set fruit. Further checks in June, 1970, 1971 and 1972 showed the plants to be persisting and in 1971 and 1972 to be spreading slightly.

Porsild (1957) notes that *Saxifraga rivularis* is found on wet and mossy areas and on wet cliffs and by brooks in the arctic. However, Britton (1957) suggests that it may be found on fairly well-drained substrates. Both the *S. rivularis* stations described here are comparatively dry,

Fig. 1. *Saxifraga rivularis* L. growing in conjunction with *Carex bigelowii* Torr. at 5,000 ft. near the Lake-of-the-Clouds Hut on Mt. Washington, New Hampshire.

certainly not as damp as would be suggested by the name "Alpine Brook Saxifrage". In past years the Mt. Washington summit locality was in a position to be influenced by leaks from a nearby water tank, but recently the tank has been removed without apparent detriment to the plants. Both stations are characterized by thin winter snow cover and by early snow melt in the spring. Porsild (1957) states that *S. rivularis* is a pronounced nitrophile growing, ". . . below bird cliffs and near human habitations". Both stations are in a position to be influenced by human wastes.

It is well that this plant has spread to at least one new station as development plans for the summit of Mt. Washington endanger the prime station for this relatively rare plant on the Presidential Range.

I wish to thank the Mt. Washington Observatory for providing living facilities, and Bruce Tiffney and Lindsay Fowler for their assistance.

LITERATURE CITED

Britton, M. E. 1957. Vegetation of the arctic tundra, p. 67-130 *in* H. P. Hansen (ed.), Arctic biology. Oregon State Univ. Press (1967). 318 p.

Pease, A. S. 1964. A flora of northern New Hampshire. New England Bot. Club, Cambridge, Mass. 278 p.

Porsild, A. E. 1964. Illustrated flora of the Canadian Arctic Archipelago (Second ed.). National Mus. Canada Bull. 146, Ottawa. 218 p.

WESLEY N. TIFFNEY, JR.
BIOLOGY DEPT., UNIV. OF MASS./BOSTON
100 ARLINGTON ST. 02116

TWO INTERESTING PLANTS ON MT. CARDIGAN, ORANGE, NEW HAMPSHIRE. Many interesting occurrences of plants are reported by Frank Seymour in his excellent Flora of New England. One of the most unusual was his discovery of *Carex capitata* L. on Mt. Cardigan in 1960 at an elevation of 3200 feet. In New Hampshire, *Carex capitata* is known otherwise only on Mt. Washington where a few small colonies of it occur in moist peaty moss at an elevation of 5000 feet. It does not grow on Mt. Katahdin but is found in Newfoundland and the arctic.

The report of it on Mt. Cardigan seemed so unlikely that the authors thought possibly some mistake had been made and decided to investigate. Accordingly in September, 1972 they climbed the mountain. Above 2500 feet ledges and bare rock were encountered but no unusual plants. The west side of the summit consists of large expanses of bare sloping rock with occasional patches of soil or clumps of dwarf trees. In this area a colony of *Carex capitata* was soon located. It was growing in dry open soil along with *Potentilla tridentata* Ait. Eventually 3 colonies were found in similar situations, the largest of which was 20 feet in diameter. The plant was in abundance in each colony and seemed to be more vigorous than on Mt. Washington.

All of the summit area was searched and eventually a small colony of *Carex Bigelowii* Torr. was located in a dry peaty area. It later developed that this plant had been found there by Steele in 1955 but not reported. Various plants that might be expected in such a mountainous situation were found but nothing else unusual. *Carex Bigelowii* is confined to alpine areas, except for this situation but has a wide distribution. It is common on the Presidential and Franconia Ranges and also occurs on The Twin Range, and on Mt. Moosilauke.

It is very difficult to account for the presence of these plants, especially *Carex capitata* which is rare even on Mt. Washington, and the authors cannot even agree between themselves as to the most likely explanation.

About 100 years ago there was a fire on Mt. Cardigan which was so spectacular that it was seen for miles and an eastern promotory received the name Firescrew. Presumably the fire drastically altered the environment, creating new open habitats thus providing a suitable site for *Carex capitata* which then seeded in. The difficulty with this hypothesis is that Mt. Washington is 50 miles to the northeast and it is hard to see how the fruits could have been transported. They are comparatively heavy and not windborne and, if eaten by birds, would presumably be digested, destroyed or lost. Furthermore the plant is of such limited occurrence on Mt. Washington that it seems too much of a coincidence to suppose that a bird had transported it to Cardigan, especially when there are many other suitable sites closer at hand. Even though *Carex Bigelowii* is a much commoner plant it is not easy to see how its fruits could have been transported.

Another explanation is that *Carex capitata* existed on Mt. Cardigan as a relic since the retreat of the glacier. There undoubtedly were ledges and probably small peaty openings where it might have survived. If this were the case, however, it is very difficult to explain why it or other more common arctic alpines are not found on some of the numerous apparently suitable sites on other mountains. The reason

it is not found in such situations is undoubtedly that it cannot withstand competition with other plants. It is very difficult to see how it could have survived on Cardigan for thousands of years as would have to be the case if it were a true glacial relic.

There is a third possibility, not very attractive, but not easy to disprove, and that is that some botanist for reasons best known to himself, transplanted the plants there from Mt. Washington. Two instances are known of transplants on Mt. Washington and there are many instances of plants being moved to lowland sites where they do not long persist. It is perhaps significant that although the plant is fairly conspicuous it was not discovered on Cardigan until Seymour found it in 1960.

It will be very difficult to decide positively among these possibilities. This article is being published partly so that some botanist 50 years from now can compare the distribution of the plants with their present state.

F. L. STEELE
THE WHITE MOUNTAIN SCHOOL
LITTLETON, NEW HAMPSHIRE 03561

A. R. HODGDON
DEPT. OF BOTANY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM 03824

NEW OR NOTEWORTHY NEW HAMPSHIRE PLANTS

DAVID E. BOUFFORD

In the course of field studies during 1971 and 1972 several plants previously unreported in New Hampshire were found. They are listed here along with some new stations for a few other noteworthy plants of the New Hampshire Flora. Collections were made of all and a specimen of each has been deposited in the Keene State College Herbarium. Duplicates have been sent to the University of Massachusetts Herbarium in Amherst, Massachusetts and except for *Spiranthes lucida, Dentaria laciniata* and *Dicentra canadensis* to the University of New Hampshire Herbarium. All collections were made by me and the collection numbers are my own.

Salix amygdaloides Anderss. Outlet of Meetinghouse Pond, Marlborough, Cheshire County, 5 May 1971 (flowering), and 1 July 1971 (mature foliage), *Boufford* 1938; tree about 8 m. tall. Seymour cites a specimen collected in Lenox, Massachusetts and deposited in the Pringle Herbarium of the University of Vermont as the only verified collection from New England. He also says it is reported from Vermont. Gray's Manual, 8th ed., gives the range as being from Vermont westward.

Clematis dioscoreifolia Levl. & Vaniot. Steep roadside bank, Rte. 12 in Walpole, Cheshire County, 24 July 1972, *Boufford* 7268. Several well-established plants in rather dry soil. Seymour calls this plant rare. Including var. *robusta* he mentions just six New England towns where it has been collected, only one being in Vermont and none in New Hampshire or Maine. Fernald (1950) says, "occasionally spread from cult., Mass. to Va."

Cassia nicitans L. Railroad ballast, approximately 0.5 mile south of Swanzey line in Winchester, Cheshire County, 25 August 1971, *Boufford* 4441. Seymour lists no collections from New Hampshire or Maine, but there are some from

Vernon, Vermont. This appears to be the northeastern edge of the plant's range.

Baptisia australis (L.) R. Br. Old field just south of the intersection of Rtes. 119 and 10 in Winchester, Cheshire County, 20 June 1972, *Boufford* 6041. Several clumps of the plant were well-scattered throughout the field. A house several hundred yards away has many plants around it and is the obvious source of this escape.

Thermopsis villosa (Walt.) Fernald & Schubert. Roadside and railroad bed, Rte. 12 in Walpole, Cheshire County, 19 June 1971, *Boufford* 2786. The majority of the plants are on a steep, dry roadside bank, but some are scattered up to a quarter mile away, indicating that the plant is spreading. This plant is growing with the previously mentioned *Clematis dioscoreifolia.*

Digitalis lutea L. Roadside Rte. 10 just north of Beaver Brook Falls and junction with Rte. 9, Keene, Cheshire County, 14 July 1971, *Boufford* 3529. Over a hundred plants make up the colony. There is a specimen in the herbarium of the New England Botanical Club of *D. lutea* made from a garden planting and with the notation on the label stating, "Brought from Keene where growing wild." Wakefield, July 2, 1944, Coll. R. C. Bean. Whether or not this is the same colony is not known. A proposed dam in the immediate area will no doubt destroy the colony if construction begins.

Hieracium vulgatum Fries. Roadside along Spaulding Brook, Sullivan, Cheshire County, 31 July 1972, *Boufford* 7433. Several plants. This plant has been collected in all the surrounding states, but not in New Hampshire.

Hieracium umbellatum L. Beech Hill, Keene, Cheshire County, 23 September 1971, *Boufford* 4988. Large colony of several hundred plants mostly in thin, sandy woods, but extending into deeper woods. There is a collection in the herbarium of the New England Botanical Club and another in the Gray Herbarium; both are from Massachusetts and appeared as transient waifs. The station in Keene is apparently the first in New England where the plants are thoroughly

established. Gray's Manual states that the plant is western and Eurasian and comes east only to Michigan.

The following four species, collected on the shore of the Connecticut River below the Bellows Falls dam in Walpole, Cheshire County, have been collected elsewhere in New Hampshire but are unusual enough in that state to deserve mention.

Tofieldia glutinosa (Michx.) Pers. 13 August 1971, *Boufford* 4164. Previously reported only from Plainfield in New Hampshire.

Spiranthes lucida (H. H. Eaton) Ames. 7 July 1971, *Boufford* 3313. Also known in New Hampshire only from Plainfield. Quite abundant.

Cardamine pratensis L. 29 May 1971, *Boufford* 2122. Reported previously in New Hampshire only from Croydon.

Lobelia Kalmii L. 13 August 1972, *Boufford* 4153. Several scattered plants.

This area below the Bellows Falls Dam is rather unusual. The shore consists mostly of ledge and loose boulders. It is completely inundated by torrents of water in the spring; during the summer several seepage streams flow from the upper banks to the main channel of the river.

Overlooking the Connecticut River station on the dry south-facing slope of Fall Mountain in Walpole, Cheshire County, were found two more interesting plants: *Asclepias quadrifolia* Jacq., 5 June 1972, *Boufford* 5686, and *Solidago odora* Ait., 10 August 1972, *Boufford* 7603. The only New Hampshire station known previously for the *Asclepias*, according to Seymour, was in Charlestown. However, there is a specimen of this plant in the University of New Hampshire Herbarium, collected in 1890 by William S. Harris in Windham, Rockingham County. According to Gray's Manual, this station would be at about the northeastern limit of the range.

Further south still, in the Connecticut River Valley and just across the Walpole line in Westmoreland, Cheshire County, was found a large colony of *Dentaria laciniata*

Muhl., 10 June 1971, *Boufford* 2527, previously reported from Rumney and Plainfield in New Hampshire.

A station for *Dicentra canadensis* (Goldie) Walp. was found on a north-facing slope in Alstead, Cheshire County, near the Surry line, 11 May 1972, *Boufford* 5105. It had been reported by Seymour to occur from Hanover northward in New Hampshire. Dr. Albion Hodgdon of the University of New Hampshire says that it is also growing in Plainfield, Sullivan County.

At Sumner's Falls in Plainfield, Sullivan County, was found *Rhynchospora capillacea* Torr., 22 August 1971, *Boufford* 4364. The only previous report for New Hampshire was in Freedom.

Mirabilis nyctaginea (Michx.) MacM. was found in a weedy area behind a gas station on Main Street in Concord, Merrimack County, 25 August 1972, *Boufford* 8067. Although Seymour does not show a record of this in New Hampshire, there is one specimen in the herbarium of the University of New Hampshire from Rochester.

I wish to thank Mr. Harry E. Ahles of the University of Massachusetts for the identification of *Salix amygdaloides* and *Hieracium umbellatum*. However, responsibility for the accuracy of all identifications is solely my own.

LITERATURE CITED

FERNALD, M. L. 1950. *Gray's Manual of Botany*, eighth edition. American Book Company, New York, 1632 p.

SEYMOUR, FRANK C. 1969. *The Flora of New England*. The Charles Tuttle Company, Rutland, Vermont. 596 p.

RFD 2 BOX 357
KEENE, NEW HAMPSHIRE 03431

CHIMAPHILA MACULATA (L.) PURSH IN MAINE AND NEW HAMPSHIRE

A. R. HODGDON AND LESLEY M. EASTMAN

The Spotted Wintergreen, *Chimaphila maculata* was reported by Seymour (1969) from Lee and Goffstown in New Hampshire and from Rutland and Windham counties in Vermont, those being the only localities given for northern New England. In this article we are discussing several recently discovered stations and citing herbarium records of several others in New Hampshire that have been overlooked.

In northern New England *Chimaphila maculata* tends to occur as disjunct colonies of a few individuals or sometimes single plants, in this respect resembling some species of orchids. Even with careful searching it is usually impossible to find any more plants after having found a few shoots at any one station. While the stems are of low stature and stand but a few inches above the forest floor, the leaves are conspicuous and easy to detect. Thus one can assert with some confidence that the population of Spotted Wintergreen in northern New England is sparse. Not only do there seem to be few colonies but there appear to be few individuals as well. Although the species in our area is scarce it is quite possible that it is considerably more frequent that the few records would indicate.

The recent discovery of it at the base of Mt Agamenticus in York, York County, Maine on October 3, 1971, by the junior author and C. Paul Wight is the first report from the state. The plant was growing in a large rocky depression which was filled with matted beech and maple leaves. It had shown no signs of flowering and on a subsequent visit to the same area in the fall of 1972, the plant had not flowered. Only the one specimen was seen on Mt Agamenticus and in lieu of collecting the solitary specimen, photographs were taken which are on deposit at the herbaria of the University of Maine and the New England Botanical

Club. Several years ago the senior author attended a field excursion of the New England Wild Flower Society at their well known stand of *Rhododendron maximum* in Sanford, York County, Maine. At the end of the tour, one participant reported the presence of Spotted Wintergreen as a limited colony somewhere along the trail into the tract of Rhododendrons. Such a report should be supported by a photograph or an identifiable fragment of a plant but it does seem entirely probable that *Chimaphila maculata* occurs in Sanford. It should be sought farther north even into Oxford County where many species of southern affinity have been found.

More evidence that Spotted Wintergreen is much more frequent than supposed comes from New Hampshire: on October 3, 1972 the senior author and some members of his class in aquatic vascular plants found scattered plants of it in dryish or at least well-drained deciduous woods on the western bank of the Oyster River in Durham, Strafford County, along that part of it known locally as the Mill Pond. Durham has received more botanical attention from the senior author than any other area of similar size anywhere and the *Chimaphila* station is only about a mile from the campus of the University of New Hampshire. It might be argued that the species has invaded the area during the ten or twelve year period since the time when the area was carefully botanized. However, the fact that the plants, though few in number are scattered over a considerable area and indeed occur on both sides of the Oyster River where it empties into the "Mill Pond" suggests that the colony or colonies have been there for some time. Also having seen the Spotted Wintergreen a number of times during the past ten years the senior author had the advantage of experience on his more recent visit to the same area.

A fragment sufficient for identification was collected at the Durham Station, October 3, 1972. *A. R. Hodgdon, L. Loiselle* and *J. Wicks* 19631. This is deposited in the herbarium of the University of New Hampshire. Earlier

in the summer on August 9, 1972, the senior author in company with Frederic L. Steele and Edward Flaccus made a leisurely ascent of Sentinel Mountain in Tuftonboro, Carroll County, New Hampshire. At about the middle of the south facing rocky slope in deciduous forest a single specimen was sighted from which one leaf was removed as a voucher. A few yards away one or two other shoots were seen, one having been in flower. Although further search was made no more plants were found that day. This specimen, August 9, 1972. *Hodgdon, Steele and Flaccus* 19632 is also deposited in the herbarium of the University of New Hampshire.

These records of recent years extend the range of *Chimaphila maculata* into Maine and central New Hampshire but there are several other townships in New Hampshire from which specimens are present in the University of New Hampshire Herbarium. These are listed as follows:

ROCKINGHAM CO. North Hampton, May 14, 1969. *A. R. Hodgdon & E. J. Hehre* 18314; Windham, July 30, 1898, *W. S. Harris*, s.n.; HILLSBORO CO. Pelham, Gumpas Pond area, 1950, *J. Straughan*, s.n.; CHESHIRE CO. Marlboro, north side of Clapp Pond, Sept. 20, 1954, *Carl Webber*, s.n.

The Harris Collection from Windham was reported in Rhodora (1949). In summary there are authentic records of *Chiamaphila maculata* from York, York Co., Maine, and the following New Hampshire stations: Tuftonboro, Carroll Co., Lee and Durham in Strafford Co., North Hampton and Windham in Rockingham Co., Goffstown and Pelham in Hillsboro Co. and Marlboro in Cheshire Co. There is some evidence also that it grew a few years ago in Sanford in York County, Maine. Also an additional station in Lee was discovered several years ago and during the summer of 1972 it was found again in Windham by Mrs. Clotilde Straus.

We would like to emphasize that care should be exercised to document stations for this rare species without destroying entire shoots, photography being recommended for that purpose.

Without some knowledge of the history of a colony it is impossible to determine whether the plant has arrived recently, or instead, has been in that particular area for a long time. Over a span of several years it should be possible to collect much useful information by repeated or at least annual visits to the same plant or colony, at the same time recording data on the spread or recession of the colony, the size and vigor of plants, the condition of flowering, etc. In this way we may be able to determine whether the species has recently migrated, is becoming extinct locally or is merely persisting. Those who argue for its recent migration to those places where it has recently been found must bear in mind that in northern New England there are few sources of the seeds and that the chance of their being lifted from near the surface of the protected forest floor and effectively transported many miles is highly improbable.

LITERATURE CITED

HODGDON, A. R. and HERBERT FRIEDLANDER. 1949. Rhodora 51: 111.

SEYMOUR, F. L. 1969. The Flora of New England, Charles E. Tuttle Co., Rutland, Vt.: 425.

DEPARTMENT OF BOTANY
UNIVERSITY OF NEW HAMPSHIRE, DURHAM 03824

OLD ORCHARD BEACH, MAINE 04064

SOME NEW LOCALS IN THE MAINE FLORA. Botanical excursions in Maine during the seasons of 1971 and 1972 have resulted in the discovery of some interesting and unusual plants.

Aster dumosus L. North side of Lovewell Pond, Fryeburg, Oxford County, September 3, 1971. During a day visit in the Fryeburg area a friend led me to where excavation work was being done to uncover an ancient Abenaki campsite. It was at this digging that I found a large number of these Asters growing in the damp yellow sand along the shore. This location is an extension of its known range, it never having been found north of York County. Another plant of interest growing in the same area was *Panicum rigidulum*.

Isotria medeoloides (Pursh) Raf. North Sebago, Cumberland County. Ninteen years ago Mrs. Iva Knight of Kennebunk found the only known station of this rare orchid in the state. During the preceding years she visited this location three or four times but never saw signs of this plant again. It was doubtful that after nineteen years *Isotria* could ever be found, but on June 7, 1972, following a well defined map which Mrs. Knight had drawn for me, I found the area, and within a very short time I came upon two of the plants. These orchids were growing under deciduous trees in leaf mould next to a small brook. It was interesting to note that a number of plants of *Habeneria Hookeri* were growing in the same area.

Epipactis Helleborine (L.) Crantz. This European weed orchid was first reported in the state about ten years ago by Dr. A. E. Brower of Augusta. He found this orchid growing at Benton Falls, in Kennebec County. I have come across this plant numerous times in the past two years. On August 7, 1971, C. Paul Wight and I found two stations of *Epipactis* growing among white pines in Cornish, York County. A week later, I found another station under red maples in Saco, York County. The following week I found

it growing in a dense beechwood growth in Stow, Oxford County.

On August 6th of 1972, while walking along a large glacial esker called "the Ridge" in Chesterville, Franklin County, I found *Epipactis* growing on the gravel slopes among grasses and ferns. I found it again on the same day, on Day Mountain in Strong, Franklin County, where it was growing in profusion from the base of the mountain to the summit. The eastern slope of the mountain is composed of calcareous slate in which many rare plants can be found, namely *Panax quinquefolium*, *Carex plantaginea*, *Dryopteris Goldiana* and *Asplenium Trichomanes*. An account of the flora of Day Mountain by C. H. Knowlton can be found in one of the early numbers of this journal (Rhodora **6**: 206, 1904).

Conopholis americana (L.) Wallr. Day Mountain, Strong, Franklin County, August 30, 1972. While exploring the eastern part of the mountain I came across a number of these root parasites growing under red oaks. This is well north of previously reported stations at York, Cumberland, Oxford, and Androscoggin Counties.

Specimens of the species mentioned have been deposited in the herbaria of the University of Maine and the New England Botanical club. Photographs were deposited in lieu of specimens in the case of *Isotra medeoloides*.

LESLEY M. EASTMAN
OLD ORCHARD BEACH, MAINE 04064

Volume 75 No. 801, including pages 1-168, was issued March 30, 1973.

INSTRUCTIONS FOR CONTRIBUTORS TO RHODORA

Manuscripts must be double-spaced or preferably triple-spaced (not on corrasable bond), and a list of legends for figures and maps provided on a separate page. Footnotes should be used sparingly, as they are usually not necessary. Do not indicate the style of type through the use of capitals or underscoring, particularly in the citations of specimens, except that the names of species and genera may be underlined to indicate italics in discussions. Specimen citations should be selected critically especially for common species of broad distribution. Systematic revisions and similar papers should be prepared in the format of "The Systematics and Ecology of Poison-Ivy and the Poison-Oaks," W. T. Gillis, Rhodora 73: 161-237, 370-443. 1971, particularly with reference to the indentation of keys and synonyms. Papers of a floristic nature should follow, as far as possible, the format of "Contribution to the Fungus Flora of Northeastern North America. V.," H. E. Bigelow & M. E. Barr, Rhodora 71: 177-203. 1969. For bibliographic citations, a recommended list of standard journal abbreviations is given by L. Schwarten & H. W. Rickett, Bull. Torrey Bot. Club 85: 277-300. 1958.

Readers of RHODORA will miss the names of three long-time editors on the front cover of this issue. As a matter of policy we have decided not to continue the custom of recent years of including the inactive editors. This is being done now to make it clear who are responsible for the work of editing the Journal and to make it easy to simplify the list when more changes in editors will be necessary after the present year.

We want to extend our appreciation for their many editorial contributions to Albert Frederick Hill who replaced Ludlow Griscom on the Board in 1944, to Ralph Carleton Bean who became an editor in 1949 and to Richard Creighton Foster who has served as an associate editor since 1961.

Albion R. Hodgdon
Editor-in-Chief

CONTENTS: — *continued*

A Re-evaluation of Potamogeton fibrillosus Fern. (Potamogetonaceae)
Robert R. Haynes and *James L. Reveal* 75
The Audouinella Complex (Rhodophyta) in the Western Sargasso Sea
William J. Woelkerling 78
Salt Concentrations in Ground Waters beneath Rhizophora mangle and Avicennia germinans
Loring Morrow and *Norton H. Nickerson* 102
Variation of Seed Size in Atriplex patula var. hastata (L.) Gray
Frank R. Drysdale 106
Floral Dimorphism in Rachicallis americana (Jacq.) Hitch. (Saltwater-Bush)
Norton H. Nickerson and *Joseph W. Tripp* 111
Book Review
Rolla Tryon 114
A New Alaskan Species of Erigeron L. (Compositae)
Stephen A. Spongberg 116
Tribal Classification of Triosteum (Caprifoliaceae)
Water H. Lewis and *Paul R. Fantz* 120
Chromosome Pairing in Obligately Apogamous Ferns; Pellaea atropurpurea and Pellaea glabella var. glabella
Sylvia Jane Rigby 122
The Past and Present Geographical Distribution of Petalostemon foliosus and Notes on its Ecology
Jerry M. Baskin and *Carol C. Baskin* 132
Book Review
Albion R. Hodgdon 140
Umaldy T. Waterfall (1910-1971)
Jack W. Stanford 146
The Environment of Schistostega pennata (Hedw.) Hook & Tayl.: New Vermont Stations
Donovan R. Bowley 149
A New Station for Saxifraga rivularis L. in the White Mountains, New Hampshire
Wesley N. Tiffney, Jr. 153
Two Interesting Plants on Mt. Cardigan, Orange, New Hampshire
F. L. Steele and *A. R. Hodgdon* 155
New or Noteworthy New Hampshire Plants
David E. Boufford 158
Chimaphila maculata (L.) Pursh in Maine and New Hampshire
A. R. Hodgdon and *Lesley M. Eastman* 162
Some New Locals in the Maine Flora
Lesley M. Eastman 166
Instructions for Contributors 168
Editor's Note 168

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

ALBION REED HODGDON, Editor-in-Chief

ROLLA MILTON TRYON
RADCLIFFE BARNES PIKE
STEPHEN ALAN SPONGBERG
GERALD JOSEPH GASTONY
ALFRED LINN BOGLE
} Associate Editors

Vol. 75 **June, 1973** **No. 802**

CONTENTS:

A Revision of North American and Caribbean Melanthera (Compositae)
James C. Parks 169

Senecio anonymus Wood, an Earlier Name for Senecio smallii Britton
Robert R. Kowal and *T. M. Barkley* 211

A Note on the Karyology of Haplopappus spinulosus (Pursch) DC. ssp. typicus
L. S. Gill and *C. C. Chinnappa* 220

Floral Structure, Hybridization and Evolutionary Relationship of Two Species of Mimulus
Y. T. Kiang 225

(Continued on Inside Back Cover)

The New England Botanical Club, Inc.
Botanical Museum, Oxford St., Cambridge, Mass. 02138

RHODORA. — A quarterly journal of botany, devoted primarily to the flora of North America and floristically related areas. Price $10.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes, and single copies are available. For information and prices write RHODORA at address given below.

Scientific papers and notes, relating directly or indirectly to the plants of North America, will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. All manuscripts should be double-spaced throughout. Please conform to the style of recent issues of the journal. Illustrations can be used only if the cost of engraver's blocks is met through the author or his institution. Forms may be closed five weeks in advance of publication. Extracted reprints, if ordered in advance, will be furnished at cost.

Address manuscripts and proofs to Albion R. Hodgdon,
Dept. of Botany, Nesmith Hall, University of New Hampshire,
Durham, New Hampshire 03824

Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of March, June, September or December.

Second Class Postage Paid at Boston, Mass.

MANUFACTURED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Vol. 75 June, 1973 No. 802

A REVISION OF NORTH AMERICAN AND CARIBBEAN *MELANTHERA* (COMPOSITAE)

JAMES C. PARKS

The genus *Melanthera* Rohr *sensu stricto* comprises a small group of helianthoid composites restricted to the Western Hemisphere. The center of distribution is Caribbean, with representatives present in Mexico, Central America, South America, and the southeastern United States. The various species occupy beaches, pine flatwoods, and moist or dry forests from sea level to fairly high mainland elevations. *Melanthera aspera* exhibits weedy tendencies. This ecological and corresponding morphological variability, coupled with the wide distribution of some species in habitats favorable for collecting, has led to a proliferation of synonyms in the genus. Natural hybrids also have contributed to the confusion.

Although Schulz (1911) published the only comprehensive revision of North American *Melanthera*, his ineffective reconciliation of biological and nomenclatural problems has caused most subsequent workers to rely on regional manuals for identification. Standley (1938) cogently expressed the difficulties encountered in dealing with *Melanthera* but, I believe, offered a much too conservative solution in recognizing only one species.

In the present treatment of *Melanthera*, I recognize five species and two varieties, and provide a morphological and nomenclatural basis for more intensive studies of all taxa

in the genus. During the course of this investigation, my personal collections and approximately 2200 herbarium specimens from 27 herbaria have been examined. (A complete list of specimens studied is available from the author upon request.) An important aspect of this revision has been the observation of living plants of *Melanthera* both in the field and in the greenhouse. Specimens of all taxa were either transplanted from the field or germinated from seed and grown in the Vanderbilt University greenhouses. Observation for approximately two years was most helpful in discovering and evaluating taxonomic characters at all stages of development.

HISTORICAL ACCOUNT

Elements of the genus *Melanthera* were first described by Dillenius (1732) in his *Hortus Elthamensis* in which he mentioned that the description was based on live plants grown from seed shipped from Carolina. Linnaeus (1753) cites Dillenius' polynomial under the name *Bidens nivea*. The second of Dillenius' two excellent plates (*t. 47*), each representing leaf variations, best serves as the lectotype for *Melanthera nivea* (L.) Small. Patrick Browne (1756) described another species of *Melanthera* based on Jamaican material and placed it in his genus *Amellus*, giving it a polynomial epithet. Linnaeus subsequently acquired Browne's herbarium, and his treatment of Browne's genera *Amellus* and *Santolina* has resulted in confusion for students of *Melanthera*. Robert Brown (1817) correctly elucidated this problem, but a few points should be noted here.

Linnaeus apparently concluded that the Browne specimen, now housed in the Linnaean herbarium as *Bidens nivea*, was equal to *B. nivea* of *Species Plantarum* (1753), for he cited it in *Amoen. Acad.* 5: 381 (1759) as part of the Jamaican flora. However, each of these elements represents a distinct species of *Melanthera*. *Bidens nivea* of the *Species Plantarum* (1753) is *M. nivea*, a species restricted to the mainland, and *B. nivea* of the *Amoen. Acad.* (1759) is *M. aspera* Jacq. As a partial result of the Linnaean con-

fusion, the Browne specimen identified as *Bidens nivea* eventually came to represent the name, while the Dillenean plate was ignored. Michaux (1803) redescribed the true *B. nivea* as *Melananthera hastata*, the epithet commonly used today.

The genus *Amellus* P. Bn. (1756) would be the valid name for *Melanthera* except that Linnaeus selected it for a distinct assemblage of species (*Syst. Nat.*, 1759, p. 1225 and 1377), and this latter usage has been conserved (Lanjouw *et. al.*, 1966). *Melanthera* was described by Rohr (1792) who used specimens from Martinique. Although Rohr did not include a specific epithet or cite specimens, his clear description, plus the fact that only one species of *Melanthera* grows on Martinique, soundly establishes *M. aspera* as the type species. Rohr's editor, Vahl, included a citation to *Bidens nivea* in Swartz (1791), which is *Melanthera aspera.*

Strother (1970) established that specimens in Copenhagen likely represent material Rohr used in describing *Melanthera.* I examined photographs and drawings of these specimens and find them to represent material of *M. aspera* var. *glabriuscula.* I compared Rohr's specimens to the Dillenean plates typifying *M. nivea* and to Jacquin's description and plant of *M. aspera* and find them closer to the Jacquin work. I agree with Strother that *M. nivea* should not be the type species of *Melanthera.* Thus, I find it strange that he would select *M. panduriformis* H. Cass., which he correctly observes to be a taxonomic synonym of *M. nivea* based on a trivial leaf-form variant, to typify the genus.

Adanson (1763) described the genus *Ucacou* based on material now distributed in *Melanthera* Rohr (1792) and *Synedrella* Gaertn. (1791). J. E. Dandy of the British Museum (1969, and personal correspondence, 1968) has found that *Synedrella* best typifies *Ucacou* and has proposed conservation of the former.

Browne's *Amellus* species was described by Jacquin (1788) as *Calea aspera,* and in 1803 Michaux described

the genus *Melananthera* with the epithets *hastata* and *deltoidea*, which are synonyms for *nivea* and *aspera* respectively. Cassini (1823) contributed a thorough morphological discussion but added three superfluous epithets. In 1850 A. Richard described *M. angustifolia*. Later, J. K. Small (1903, 1905) described the Florida endemics *M. parvifolia* and *M. ligulata*.

In my opinion, Schulz (1911), in his revision of North American and Caribbean *Melanthera*, failed to understand the morphological variability within the genus and added many superfluous names to the literature. Other early twentieth century works which treated *Melanthera* were usually floristic studies of a limited Caribbean area (e.g. Britton & Wilson, 1925) or reports of botanical expeditions (e.g. Blake, 1922, 1924, 1932, and J. K. Small, 1905, 1909). While the type specimens of some of the species described in these works appear distinct, they are actually local variants or hybrids. In this treatment I have attempted to present a comprehensive view of the genus (*sensu* Rohr) whereby the 47 specific or varietal epithets are properly disposed and the taxa clearly delimited.

INTERGENERIC RELATIONSHIPS

Most synantherologists have placed *Melanthera* in the tribe Heliantheae and the subtribe Verbesininae. Obviously *Melanthera* is morphologically similar to *Verbesina*. A difficult problem is the satisfactory delimitation of these genera. As originally defined by Rohr, *Melanthera* is said to have corollas "composita uniformis, tubulosa"; *M. aspera*, on which this description was based, is indeed discoid. In the strictest sense, then, *Melanthera* is easily distinguished from similar genera by its discoid capitulum of white florets. However, the description of *Melanthera* was broadened by later workers, e.g. Bentham & Hooker (1873), to include radiate representatives, and this concept was accepted by Wild (1965) in his treatment of the exclusively radiate African *Melanthera*. If this broadened circumscription is recognized, *Melanthera* intergrades with

Echinocephalum and *Perymenium* and is often confused with *Aspilia, Bainvillea, Eleutheranthera, Wedelia, Wulffia,* and occasionally with *Calea* and *Bidens* of the subtribe Coreopsidinae.

Possibly one or more of the genera noted should be combined with *Melanthera*. I have examined material of *Echinocephalum latifolium* Gardn. and find it nearly identical with *M. nivea* except for the pale yellow rays of the former (cf. Blake, 1930). Since consideration of these generic limits is beyond the scope of the present work, I have eliminated South America, and hence *Echinocephalum*, from consideration. Therefore, I have chosen to treat only those entities which justifiably could be included in the original description. While there is some overlap in distribution of these taxa, western hemisphere *Melanthera* is centered in the Caribbean, while *Echinocephalum* and *Perymenium* are distributed principally in South America. Until further study reveals the natural relationships of these genera, *Melanthera* can be distinguished from the others, albeit somewhat artificially, by its discoid capitulum. Distinguishing morphological features of *Melanthera* are presented in Table I.

CYTOLOGY

Chromosome counts of $n=15$ for two species of *Melanthera* have been reported by Turner *et al.* (1961), Powell & Turner (1963), and Turner & Flyr (1966). Upon examining the vouchers of these plants, I find the specimen cited by Turner & Flyr (1966) is indeed *M. aspera* var. *glabriuscula*, but those cited by Turner *et al.* (1961) and Powell & Turner (1963) are misidentified and represent *M. nivea*. I have studied meiotic material of all North American species of *Melanthera* using squash techniques and have determined a haploid number of $n=15$ for all of the species covered in this treatment (Table II).

ECOLOGY AND HYBRIDIZATION

Field and herbarium studies indicate that in the United

TABLE I

DISTINGUISHING MORPHOLOGICAL TRAITS OF MELANTHERA ROHR

Trait	*M. nivea*	*M. aspera var. aspera*	*M. aspera var. glabriuscula*	*M. angustifolia*	*M. parvifolia*	*M. ligulata*
Rootstocks	swollen-hemispheric, partly exposed	swollen	elongate-diffuse	slightly swollen	swollen-hemispheric, partly exposed	slightly swollen
Stems	erect, maroon-mottled, to 3 m	diffusely branched, to 1.5 m	diffusely branched, to 1.5 m	erect, several from rootstock, to 9 dm	decumbent-erect, often diffusely branched, to 6 dm	decumbent, many side branches, node swollen, to 9 dm
Indumentum	slightly hirsute	trichomes erect hirsute-strigose	trichomes appressed-ascending	glabrescent	trichomes erect, hirsute-strigose	glabrescent
Leaves	ovate-deltoid base often hastate; dark green; serrate	ovate; sub-coreaceous; crenulate; asperous	deltoid-ovate membranaceous crenate	lance-linear	like small M. nivea lvs., to cm, triplinerved	variable, lance-ovoid; base may be hastate, triplinerved
Capitulum no. & peduncle length	numerous on peduncles 4-12 cm	numerous on peduncles 2-14 cm	numerous on peduncles 2-17 cm	one per stem on peduncles 9-20 cm	few per stem on peduncles 2.5-10 cm	one per stem, peduncles 6-14 cm
Phyllaries	lanceolate; green tipped recurved; greatly exceed disc	lance-ovate green tipped slightly exceed disc	ovate, equal disc	ovate, equal disc	lanceolate; green tipped recurved; greatly exceed disc	lanceolate; green tipped recurved; greatly exceed disc

TABLE 1 continued

Apical aristae of pales	1.4+ mm, recurved	0.5-1.5 mm, straight	up to 0.5 mm	0.5 mm	1-1.5 mm, straight-recurved	1 mm, straight-recurved
Corolla limb	spreading	spreading	tubular	spreading	spreading	spreading
Achene apex	truncate-concave	concave-truncate	truncate or often convex-tufted	truncate-concave	concave-truncate	truncate-concave

TABLE II

CHROMOSOME VOUCHERS IN *MELANTHERA*

Taxon	*Locality and Collection*	*Repository*
M. nivea	FLORIDA. WAKULLA CO.: Newport, woods near road. *Parks* 135.	VDB
	LOUISIANA. TENSAS PAR.: moist woods near Newellton. *Parks* 337.	VDB
	MEXICO. VERA CRUZ: Cordoba, roadside, *King* 2361. cit. Turner et. al., 1961.	TEX
	Huatusco, roadside, *Powell* 642. cit. Powell and Turner, 1963.	TEX
M. aspera var. *aspera*	FLORIDA. COLLIER CO.: Naples, back of beach, sand, roadside. *Parks* 124.	VDB
	SARASOTA CO.: Longboat Key, oolitic spoil bank. *Parks* 125.	VDB
M. aspera var. *glabriuscula*	FLORIDA. MONROE CO.: Long Key, dry beach. *Parks* 98.	VDB
	Islamorada, *Anderson* 3226. cit. Turner and Flyr, 1966.	TEX
M. angustifolia	FLORIDA. COLLIER CO.: Monroe Sta., moist glade, on oolite. *Parks* 298.	VDB
M. parvifolia	FLORIDA. MONROE CO.: Big Pine Key, dry pine flatwoods on oolite. *Parks* 289.	VDB
M. ligulata	FLORIDA. PALM BEACH CO.: Loxahatchee, dry, sunny palmetto-pine flatwoods. *Parks* 89.	VDB

States the various taxa of *Melanthera* are usually distinct morphologically and ecologically. *Melanthera nivea* inhabits fairly moist forests and borders in the lower Coastal Plain southward to central Florida. *Melanthera ligulata* frequents the low hammocks of south-central Florida but may exhibit weedy tendencies. *Melanthera parvifolia* is restricted to to oolitic "pine islands" of southern Florida and to Big Pine Key. *Melanthera angustifolia* is relatively rare, but is usually found in moist, open glades in southern Florida. *Melanthera aspera* var. *aspera* is often weedy, preferring dry, rocky places such as roadsides and calcareous spoil banks fairly near the ocean in southern Florida, while *M. aspera* var. *glabriuscula* is a strand species growing high on beaches in extreme southern Florida and throughout the Caribbean.

In Mexico and Central America, *Melanthera nivea* is usually found in the habitat already noted at altitudes above 150 m. When found at lower altitudes it may intergrade into *M. aspera* var. *aspera*, possibly due to occasional hybridization and introgression. Such occurrences may explain Guatemalan collections by *Skinner* 1867 (NY) and *Brenckle* 47-242 (WIS), each of which contains plants best placed in either *M. nivea* or *M. aspera*. Hybridization between *M. nivea* and *M. angustifolia* can be seen in *Blake* 7601 and 7601A (US), which were collected along a Guatemalan railroad bank; *M. linearis* is typified by the latter number (Blake, 1922).

A field study in southern Florida revealed a situation that seems representative of those found throughout the genus. In southern Florida, hammocks, or high spots of coquina rock run southwest from Miami into the everglades where they gradually disappear (Young, 1953). Sometimes called pine islands, these hammocks are dominated by *Pinus elliottii* and are distinct ecologically. Examination of herbarium records, including appropriate type collections of J. K. Small, indicated that a morphological gradient exists between *Melanthera parvifolia* and *M. angustifolia* along these pine islands. Plants found on oolitic

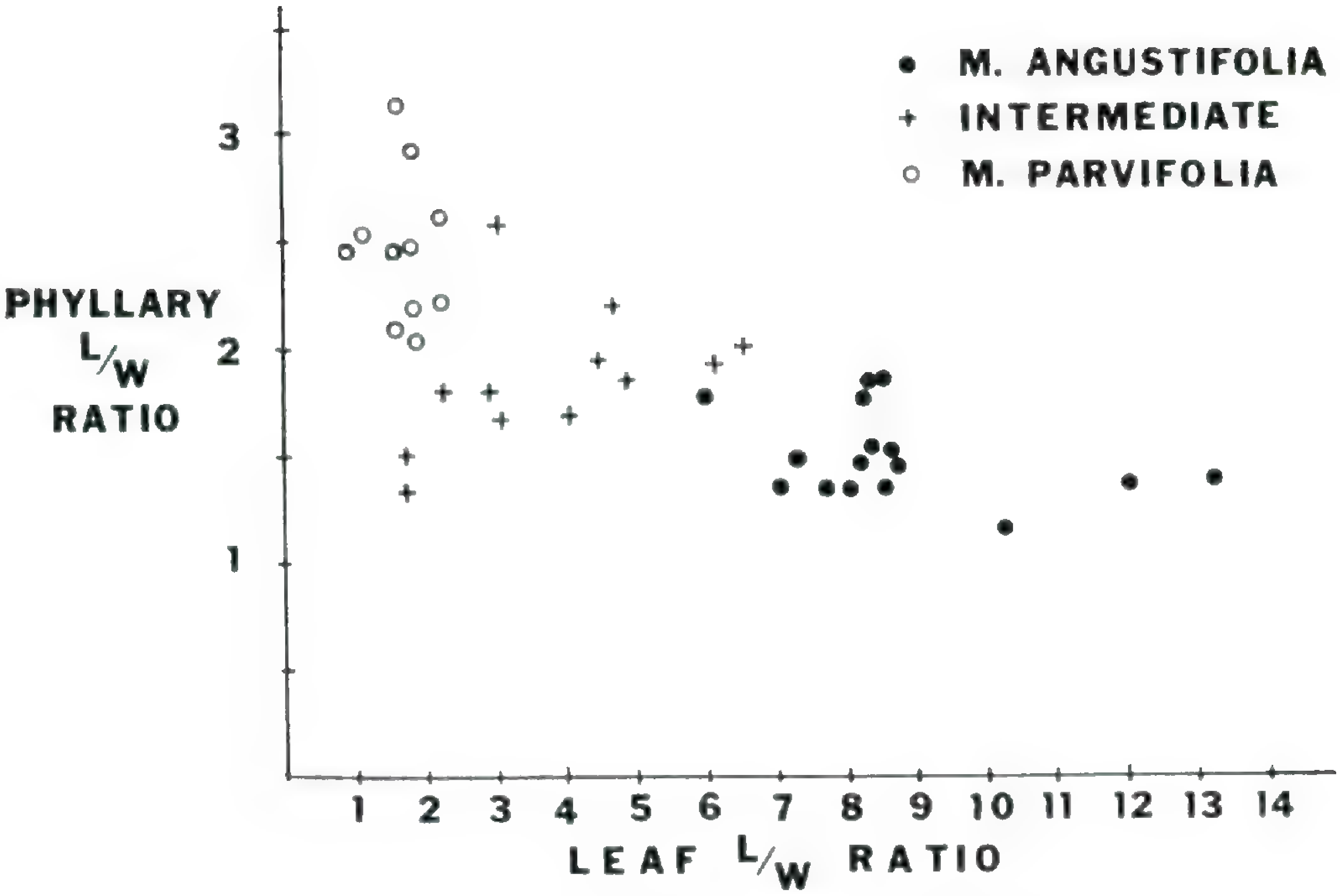


Fig. 1. Three populations of *Melanthera* from southern Florida analyzed to show interpopulational relationships of phyllary and leaf length-width ratios.

rock near Miami are much like *M. parvifolia*, while those on the lower everglades keys resemble strongly *M. angustifolia*. Morphological intermediates were collected at geographically intermediate localities.

In order that the above-described variation be understood more fully, population samples were collected and analyzed. The data obtained were analyzed (Fig. 1) in the manner of Anderson (1949). The population sample of *Melanthera parvifolia* (*Parks* 289), taken from Big Pine Key, formed a closely knit group with an average leaf L/W ratio of 1.5 and an average phyllary L/W ratio of 2.5. The population sample of *M. angustifolia* (*Parks* 298), collected near Monroe Station, Collier Co., Fla., formed a group with an average leaf L/W ratio of 8.0 and an average phyllary L/W ratio of 1.5. The other population plotted on the graph was collected on a pine island in Everglades National Park (*Parks* 280). It exhibits more variability in the traits considered, being intermediate morphologically

between *M. parvifolia* and *M. angustifolia.* Representative specimens of these populations were grown in the Vanderbilt University greenhouses under uniform conditions for about a year where they maintained their morphological distinctiveness.

This study seems to indicate that some gene exchange is occurring between *Melanthera parvifolia* and *M. angustifolia* in the area studied. This knowledge is valuable in helping to delimit properly these taxa, to annotate unusual herbarium specimens, and to determine synonymies more accurately. For example, *M. radiata* Small is quite likely an introgressant between *M. parvifolia* and *M. angustifolia.* The type collection is from oolitic rock near Miami and is similar to the Everglades Park collection noted above. As such material most closely resembles *M. parvifolia,* it is treated here as a synonym of that taxon.

During the two year period when living *Melantherae* were grown in the greenhouse, numerous reciprocal crosses were conducted to see if the taxa recognized would hybridize and to note the morphology of any hybrids recovered. Quantitative data were not taken, but vigorous F_1 offspring were recovered from all interspecific crosses and many of these were grown to flower. As the potential for interbreeding exists among all species, ecological differences appear to be most important in maintaining the identity of *Melanthera* taxa in nature. While my limited biosystematic studies have been most helpful in interpreting anomalous plants seen in both the field and herbarium, they indicate that more extensive work might be profitable in further elucidating evolutionary relationships in the genus.

PHYLOGENETIC SPECULATIONS

The origin, phylogeny, and evolution of the Compositae are lucidly discussed by J. Small (1917-1919) and Cronquist (1955). Cronquist would choose a helianthoid genus, *e.g. Wyethia,* to represent the fundamental composite group. Upland South America is the present center of dis-

tribution for the Heliantheae and the Senecioneae and contains many primitive composites.

Echinocephalum certainly would be considered a primitive genus of composites. Its geographic range includes the uplands of South America. It has opposite leaves, an herbaceous perennial habit, and a ligulate, paleaceous capitulum, all of which are accepted by many authors as primitive characters in the Compositae. *Melanthera* differs from *Echinocephalum* in that it lacks ray florets and, as a discoid capitulum is considered an advanced trait, I regard *Melanthera* to have been derived from *Echinocephalum*.

Present distributional data suggest that *Melanthera nivea* is the ancestral species of the genus. It resembles strongly *Echinocephalum latifolium* and is partially sympatric with it. Though the range of *M. nivea* is extensive, it is restricted to the mainland and, in the south, to higher elevations. Ecologically, this species prefers the stable habitat of forests and borders.

Melanthera nivea probably migrated northward from South America, the postulated area of its origin, during Eocene time and came to be continuously distributed throughout the southern United States and Mexico. As increasing aridity sporadically occurred during Oligocene and Miocene time, *M. nivea* would have failed to survive in northern Mexico and southern Texas; this failure would account for its present disjunct distribution. *Melanthera nivea* may have migrated southward into the newly formed areas of Florida during the colder climate of the Pleistocene period. Differentiation to form *M. parvifolia* and *M. ligulata* may have occurred during this and more recent time. Other plant migrations which occurred during Tertiary time are believed to have taken place in a similar manner (Chaney, 1947).

Perhaps *Melanthera nivea* migrated to the sea along the Orinoco or other local rivers, and in the process, differentiated into *M. aspera* which then was dispersed by water throughout the Caribbean. The pattern of Caribbean currents (Cruxent & Rouse, 1969) and the observation of

Millspaugh (1907) that *M. aspera* var. *glabriuscula* may readily inhabit newly formed strands or islets both support this hypothesis. The varieties of *M. aspera* may represent ecotypes developed in accordance with factors noted by Carlquist (1965). More recent differentiation, possibly from *M. aspera,* may have given rise to *M. angustifolia.* This could have occurred in one or several regions but most likely took place in southeastern Mexico or Yucatan.

SYSTEMATIC TREATMENT

Melanthera Rohr, Skriv. Nat. Selskabet (Copenhagen) **2**: 213. 1792. Type species: *M. aspera* (Jacq.) Small.

Ucacou Adanson, Familles des Plantes **2**: 131. 1763. (ex parte, non *Synedrella* propos. nom. cons.).

Lipotriche R. Br., Trans. Linn. Soc. (London) **12**: 118. 1817.

Melananthera Michx., Flora Bor. Amer. **2**: 106. 1803.

Suffrutescent perennials, 0.2-2.2 m tall, arising from a hemispheric or elongate, caudex-like rootstock. Stems one or several, quadrangular to sulcate, erect or sprawling, glabrescent to hispid-hirsute, green, sometimes with maroon mottling, rarely maroon. Leaves opposite, petiolate, triple-nerved, broadly ovate or deltoid to narrowly lanceolate-linear, glabrescent to hispid-hirsute; base attenuate, cuneate to nearly truncate, hastate or with basal lobes ascending in some species; apex mostly acute; margin crenate to serrate, sometimes irregularly so. Capitula terminal, solitary or arranged in very loose cymes, borne on rather elongate, sulcate, generally pubescent peduncles. Involucre 0.6-1.5+ cm broad, of two subequal, often loosely imbricate series, grading somewhat into pales. Phyllaries ovate to lanceolate, equal to or much longer than florets at first anthesis, apices more or less herbaceous, pallid basally with or without green nerves. Pales oblanceolate, strongly keeled and membranaceous basally where they clasp florets; apex thicker, aristate or caudate with cauda 0.4-1.5+ mm long, straight or recurved, sometimes pubescent api-

cally and marginally. Florets 25-100 per capitulum, all discoid, regular, hermaphroditic; corolla white; tube 4-7 mm long, constricted and pale yellow toward a nectariferous base; limb 0.5-1 mm long, spreading or rarely ascending, papillate adaxially, strigillose or glabrous abaxially. Anther sacs black, 1.5-2 mm long; apical appendages white, sagittate, 0.5 mm long; basal appendages absent, style branches white, 1.2-2.5 mm long, narrowing to a lanceolate, papillate or hairy tip, this partly or completely recurved upon senescence; pappus of 2 to 5+ delicately barbed, caducous awns. Achene indurate, obpyramidal, compressed-quadrangular (triangular in outer florets), 2-3 mm long, 1-2.5 mm wide; apex usually truncate or slightly concave due to marginal cusps of crown, usually convex in *M. aspera* var. *glabriuscula*, sparsely to moderately pubescent; surface usually brown with fine striations, warts and/or gold to silver mottling may be present.

Key to the Species

a. Aristae of pales greater than 1 mm, usually recurved when long; phyllaries narrowly lanceolate, the upper ½ to ¾ green, often recurved; leaf shape various but base often hastate. . . . . *b.*

b. Largest leaves 4 cm or less long; plants averaging 0.3 m in height. Southern Florida oolitic "pine islands" and Big Pine Key. . . . . . 5. *M. parvifolia.*

b. Largest leaves greater than 4 cm long; plants averaging 0.8-1 m in height. . . . . . *c.*

c. Peduncles and leaves hispid and pale aristae 1-1.4 mm long; phyllaries and pales lanceolate, moderately longer than disc, never recurved; leaves moderately coarse. Greater Antilles and tropical mainland, often weedy. . . . . 2. *M. aspera* var. *aspera.*

c. Peduncles and leaves strigose to glabrescent or if these hispid, the caudae of the pales 1.4 mm long; phyllaries and pales narrowly lanceolate, noticeably longer than disc, the longest often

recurved; leaves moderately membranaceous (occasionally rugose in *M. nivea*). . . . . *d.*

d. Plants erect, up to 2.2 m tall with several stems arising from large, woody root; leaves ovate, very rarely lanceolate, rich, dark green, often rugose, base commonly hastate, vesture moderate, strigose; larger capitula up to 2 cm across the involucre. Central Florida, the coastal plain from S. Carolina to Louisiana; Mexico, and Central America. . . . . 1. *M. nivea.*

d. Plants decumbent to weakly erect, bushlike, with one main stem freely branched at the often jointed nodes; leaves ovate to lanceolate (quite variable), rarely rugose, trichomes sparse; larger capitula up to 1.5 cm across the involucre. South-central Florida at the approximate latitude of Lake Okeechobee. . . . . 6. *M. ligulata.*

a. Aristae of pales usually 1 mm or less (may be slightly longer in *M. aspera* var. *aspera*), commonly less than 0.5 mm, never recurved; phyllaries ovate to broadly lanceolate, the upper ¼ to ½ green never recurved; leaves various, rarely hastate. *e.*

e. Leaves lanceolate-oblanceolate-elliptical, older stems glabrescent, weakly erect, av. 0.5 m in height; capitula small, av. 1 cm in diameter, mostly solitary; phyllaries ovate. Southern Florida, through Cuba to Yucatan and the tropical mainland. . . . . 4. *M. angustifolia.*

e. Leaves ovate, deltoid or weakly hastate; pubescence various; sprawling or bushy plants av. 1 m in height; capitula various. . . . . *f.*

f. Trichomes of peduncle appressed-ascending and moderately sparse; cauda of pale 0.5 mm long; phyllaries ovate; capitulum 1.3 cm wide or less across the involucre; achenes usually 2.5 mm long or less, the apex often convex-hairy, or

truncate. Beaches of the Caribbean. . . . . 3. *M. aspera* var. *glabriuscula.*

f. Trichomes of peduncle spreading (hispid) and relatively abundant; cauda of pale 1 mm long; phyllaries broadly lanceolate; capitulum 1.3 cm or more across the involucre; achenes usually 2.5 mm or more in length, the apex truncate to concave, sparsely pubescent. Greater Antilles and tropical mainland, often weedy. . . . . 2. *M. aspera* var. *aspera.*

1. **Melanthera nivea** (L.) Small, Flora SE. United States 1251, 1340. 1903. Fig. 2.

Bidens nivea L., Sp. Pl. 2: 833. 1753. Lectotype: Dillenius, J. 1732 Hort. Elth. tab. 47(!)

Athanasia hastata Walt., Flora Caroliniana 201. 1788. Type: ?

Melananthera hastata Michx., Flora Bor. Amer. 107. 1803. Type: Carolina-Virginia, *Michaux* (photo. GH!)

Melananthera hastata Michx. vars. *lobata* and *pandurata* Pursh, Flora Amer. 2: 519. 1814. based on Dillenius, *l.c.*

Melanthera panduriformis H. Cass. *in* Levrault, F. G. (ed.). Dict. Sci. Nat. **29**: 483. 1823. based on Dillenius, *l.c.*

Melanthera trilobata H. Cass., l.c. based on Dillenius, *l.c.*

Melanthera oxylepis DC., Prodr. 5: 545. 1836. Type: ex. herb. Haenke (photo & fragment US!)

Elephantopus cuneifolius Fourn., Bull. Soc. Bot. France **30**: 186. 1883. Type: not ascertained. (photo. US!)

Melanthera carpenteri Small, Flora SE. United States 1251, 1340. 1903. Type: Louisiana: W. Feliciana Par., pine thickets, *Carpenter s.n.* (NY! isotype NO!)

Melanthera lobata Small, l.c. Type: Florida; Lake Co., Eustis, lake edge, *Nash* 1141 (NY! isotypes GH! MICH! MO! UC! US!)

Melanthera oxycarpha Blake, Contr. U.S. Ntl. Herb. **22**:

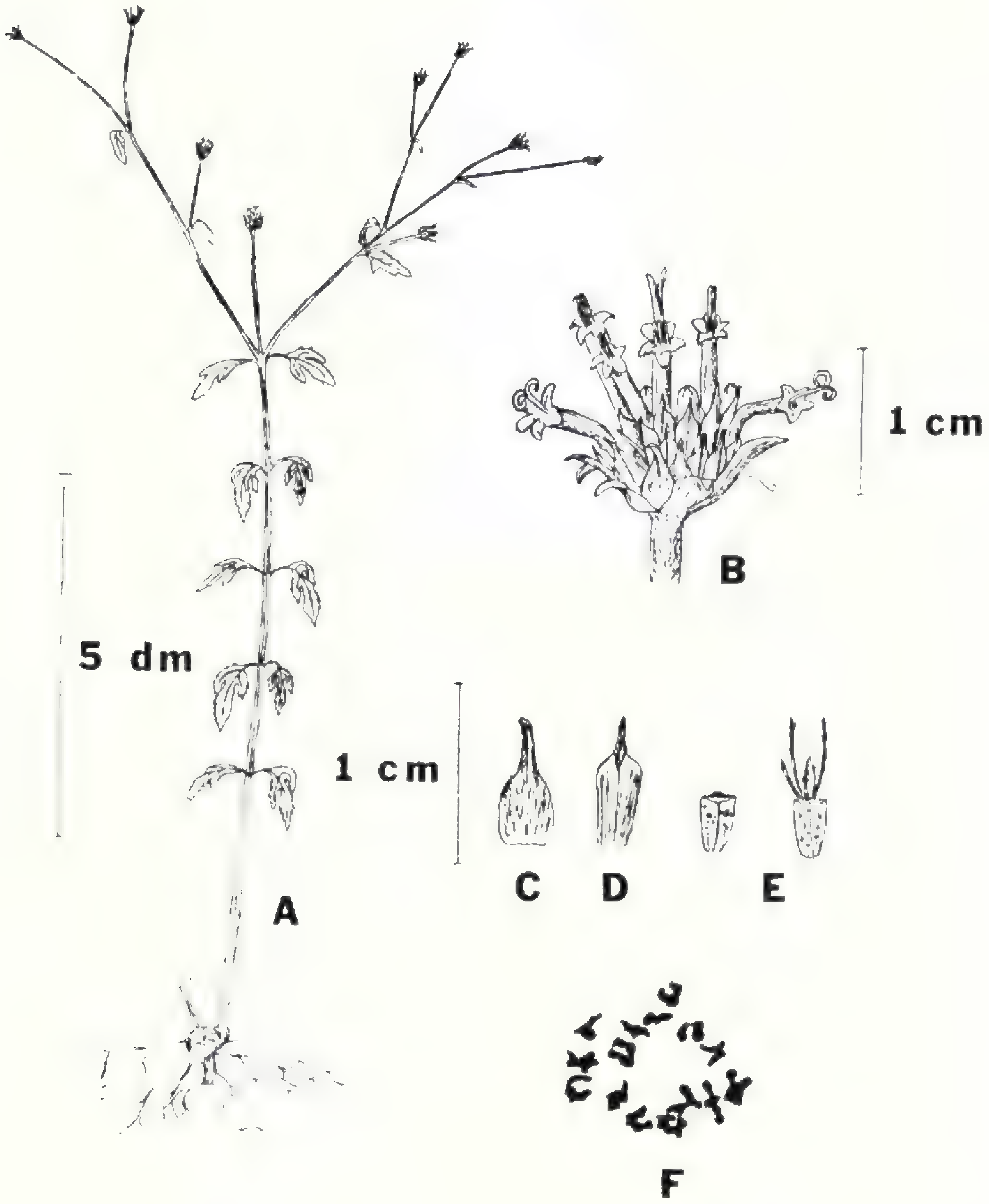


Fig. 2. *Melanthera nivea* (L.) Small. A. habit sketch, B. capitulum, C. phyllary, D. pale, E. achenes. F. meiotic chromosomes, metaphase one, × 1000.

628. 1924. Type: Mexico; Vera Cruz: Zacuapan, fields, *Purpus* 2437 (US! isotypes F! MO! UC!)

Melanthera hastata (Walt.) L. C. Rich. spp. *lobata* (Pursh) Borhidi. Botanikai Kozlemenyek 58: 177. 1971. based on Pursh, *l.c.*

Coarse, perennial, caespitose herb, 0.8-2.2 m tall arising from a woody, noticeably swollen, hemispheric, caudex-like rootstock. Stems erect, quadrangular to sulcate, green, often with maroon mottling in the hollows, branched apically, puberulent to pubescent at the nodes. Leaves mostly ovate, 8-12 cm long, 3-8 cm wide, triple-nerved, membranaceous, sometimes rugose, rich, dark green, strigose to hispidulous; base broadly acute to hastate, the lobes divergent or ascending, the petioles averaging 4.5 cm; apex acute to acuminate; margin serrate. Capitulum borne on a hispidulous, sulcate peduncle 4-12 cm long; involucre in two loosely imbricate series 1.5-2 cm broad; phyllaries lanceolate, green for ½ or more of the length apically, white with green nerves basally, strigillose, noticeably longer than florets at first anthesis; pales 5-7 mm long, 2.5 mm wide, strongly keeled, translucent and nerved basally, thicker, often red-tipped, fimbriate to pubescent apically; apical aristae 1.4+ mm long, often recurved; corolla tube 5 mm at anthesis, 6 mm at style exsertion, limb 1-1.5 mm, spreading, color snow-white, pale yellow at constricted nectariferous base; anther sacs 2 mm long; style branches long, white, often completely recurved upon senescence; pappus of 2 to several caducous awns; achene obpyramidal, 2-3 mm long, 1.5-2 mm wide; apex truncate to slightly concave, corolla base sessile; surface finely striated, often verrucose; color golden brown to dark brown.

Moist forests and borders from Lake Okeechobee, Florida, north into the Coastal Plain from South Carolina to Louisiana; then at somewhat higher elevations (usually greater than 150 meters) in Mexico and Central America (Fig. 3). Schwegman (1968) reports *Melanthera nivea*

Fig. 3. Distribution of *Melanthera* Rohr

from Massac and Pulaski Counties, Illinois. Athey (personal correspondence, 1972) says that he has collected it in McCracken, Ballard, and Livingston Counties, Kentucky. The sheets, nos. 403, 779, and 1160 respectively, are on deposit at Memphis State University. These would establish Kentucky state records for Mr. Athey. I have not yet seen these collections. Dr. Kral assures me that Athey 403, *VDB* is *M. nivea.* These are significant northern range extensions and establish this taxon in the Mississippi embayment. Flowers in summer and fall.

The unambiguous Dillenean treatment was overlooked by many later workers (c.f. Historical Account) and the epithet *nivea* was usually applied to plants properly called *Melanthera aspera.* Perhaps as a result of this confusion. Dillenius' species was renamed *Athanasia hastata* by Walter (1788) and *Melananthera hastata* by Michaux (1803). I concur with Coulter's opinion (1891) that *M. oxylepis* DC. merely represents a leaf variant common in Mexico.

In southeastern Mexico and adjacent Guatemala, *Melanthera nivea* may intergrade with *M. aspera* var. *aspera* but in the United States it is distinct in morphology and in geographic range, being best recognized in the field by its habit and on herbarium sheets by its large, dark green. often rugose leaves, lanceolate phyllaries and long-caudate pales.

REPRESENTATIVE SPECIMENS EXAMINED. EL SALVADOR: **Morazan:** stream bed in coffee grove, Montes de Cacaquatique. *Tucker* 723 (F, MICH, NY, UC, US). GUATEMALA: **Alta Verapaz:** 2 mi E of Coban, open sun, fields, *King* 3320 (DS, MICH, NY, TEX, UC, US); near Amatitlan, brushy bank, alt. 1170 m, *Standley* 61374 (F). **Izabal:** 25 km SSW Puerto Barrios, weedy openings along river in rain forest, *Raven & Gregors* 615 (F, MICH). **Soloa:** Santa Barbara. *Shannon* 589 (US). HONDURAS: **Cortes:** E of San Pedro Sula. Bosque lluvioso de Montana La Zona, alt. 190 m, *Molina* 3437 (F). **El Paraiso:** Yuscaran, moist thicket, alt. 930 m, *Standley* 25777 (F). MEXICO: **Chiapas:** 4 mi NE Bochil, slope with *Pinus & Liquidambar*, alt. 4500 ft, *Breedlove* 8838 (MICH); between Tumbala & El Salto, alt. 1500-4500 ft, *Nelson* 3389 (US). **Guerro:** 2 mi S Coahuayultla, pine-oak forest, alt. 3600 ft, *Rowell* 3086 (SMU). **Jalisco:** hillsides S of Zapotlan, *Goldsmith* 107 (DS, MO, NY, UC, US). **Michoa-**

can: Aquila, coconut grove, *Hinton* 15848 (PH, TEX, US). **Oaxaca:** 4 km NE Tehuantepec, grazed area in thorny legumes, alt. 50 m, *King* 425 (MICH). **San Luis Potosi:** 7-8 mi NE Xilitla, mountains, roadside weed, *King* 4344 (F, MICH, NY, TEX, UC, US). **Tabasco:** Tenosique, second growth, *Matuda* 3450 (F, MICH, NY, UC). **Tamaulipas:** Tampico, alt. 15m, *Palmer* 174 (F, MO, NY, US). **Vera Cruz:** Jalapa, alt. 4000 ft, *Pringle* 8194 (F, MICH, MO, NY, PH, UC, US); Orizaba, open woods, *Purpus* 1161 (F, MO, UC). NICARAGUA: **Matagalpa:** Santa Maria de Ostuma, Cordillera Central, alt. 12-1500 m, *Heller* 35, 39 (F). UNITED STATES: **Alabama:** BARBOUR CO., Spring Hill, common in swamp, *Bush* 169 (MO, NY). COLBERT CO., Muscle Shoals, *Buckley* Aug. 1826? (PH). MORGAN CO., Decatur, *Shimek* s.n. (F). MOBILE CO., Mobile, *Mohr* Aug. 1893 (MO). **Florida:** BREVARD CO., rich hammocks, Cape Canaveral, *Burgess* 684 (F, NY). DUVAL CO., Jacksonville, shore of St. John's river, *Curtiss* 1414 (F, GA, GH, MICH, MISSA, MO, NY, PH, SMU, UC). HERNANDO CO., 1 mi N of Brooksville, moist roadside shade, *Parks* 314 (F, FSU, GA, NY, PAC, SMU, US, VDB, WIS). HIGHLANDS CO., Parker Is., 5 mi S of Lake Istokpoga, among saw palmetto, edge of hammocks, *Brass* 15690 (GH, US). MARION CO., Orange Lake, in open shade around sink hole, *Parks* 224 (EVG, F, FSU, GH, NY, PAC, SMU, US, VDB, WIS). PALM BEACH CO., loc. not spec., *Hitchcock* 1026 (F). POLK CO., 7 mi E of Haines City, pineland burned & cleared 2 yrs ago, *Conard* 20 Aug. 63 (FLAS). SUMTER CO., in swamp, 0.5 mi E of wahoo ch., 5 mi W of Bushnell, *Beckner* 1582 (DUKE, FLAS). SUWANNEE CO., wooded stream bank, Ichetucknee Springs, *Will* 17 Sept. 60 (FLAS). WAKULLA CO., W side of Newport, rt. 98, roadside ditch, wooded border, *Parks* 135 (EVG, F, FSU, GH, PAC, MICH, MO, NY, SMU, US, VDB, WIS). WALTON CO., sandy, wooded ravine, rt. 81, Red Bay Springs, *Hood* 2982 (FLAS). **Georgia:** CHATHAM CO., sandy hammock, Ft. Pulaski Mon., *Eyles* 4634 (DUKE). LEE CO., rich woods along Mill Creek, *Harper* 1074 (GH, MO, NY, US). MC INTOSH CO., open live oak woods. Sapelo Is., *Duncan* 20511 (DUKE, FLAS, GH, LAF, MICH, NCU, SMU, TEX, US, USF, WIS). **Louisiana:** IBERIA PAR., disturbed, sandy soil along pipeline clearing, Weeks Is., *Thieret* 9721 (FSU, LAF, NCU, SMU, VDB). RAPIDES PAR., Alexandria, *Hale* s.n. (GH). TENSAS PAR., 8.5 mi W of Newellton, along gravel rd. from Sikes grocery, mature sweet gum-hickory bottom, *Parks* 337 (DS, DUKE, EVG, F, FLAS, FSU, GA, GH, LAF, MICH, MO, NCSC, NCU, NY, PAC, PH, SMU, TEX, UC, US, VDB, WIS). **Mississippi:** LOWNDES CO., bottom land woods, Bylers Lake, *Ray* 6683 (NCU, USF). NEWTON CO., wooded bluffs, chunky, *Bailey* 129 (MISSA). **South Carolina:** ALLENDALE CO., cypress swamp, Pipe Creek, *Bell* 18466 (NCU). BERKELEY CO., roadside ditch, 1.1 mi S. of Monck's Corner, *Bradley* 3530 (FSU, NCU, NY, VDB). CHARLESTON CO., border of live oak woods, Edisto Is. Rd., *Godfrey* 50475 (NCSC).

2. **Melanthera aspera** (Jacq.) Small, Bull. Torrey Bot. Club 36: 164. 1909.

Suffrutescent perennial, 0.5-1.5 m tall, sprawling to subscandent arising from a woody, swollen, elongate or knobby root. Stem sulcate or rounded near base, 0.5-1.5 cm in diameter, green may be maroon tinged, glabrescent to hispid particularly at nodes. Leaves ovate to deltoid, 6-12 cm long, 4-8 cm wide, membranaceous, rarely rugose, may be triple-nerved, light green and drying dark green; indument below sparse, appressed-ascending to hispid with noticeable accumulation or webbing in vein axils, erect-ascending above; base broadly acute to truncate, becoming short attenuate; petiole 1.5-4.5 cm long; apex acute to acuminate; margin crenulate-crenate to serrulate. Capitulum borne on a slender to sturdy sulcate peduncle 2-14 cm long, which has sparse appressed-ascending or abundant erect hairs; involucre in two imbricated series, 1.2-1.5 cm in diameter; phyllaries broadly ovate and 3-5 mm long, 3-4 mm wide or lanceolate and 5-7 mm long, 2-3 mm wide, tips green and equalling or surpassing the disc at anthesis by 1 mm; pales oblanceolate, 4-6 mm long, 1.5-2 mm wide, strongly keeled, translucent and nerved basally, thicker, pale green and puberulent apically, apical arista or cauda 0.5-1.4 mm long, never recurved; corolla tube 5-7 mm long, basally constricted for 1-1.5 mm, strigillose; corolla limb spreading or ascending 0.8-1.5 mm long, papillate adaxially; anther sacs 2 mm long; style branches about 2.5 mm long, partly or completely recurved when senescent; pappus of two to several caducous awns; achenes obpyramidal 2-3 mm long, 1-2 mm wide, apex truncate to concave and glabrescent or convex and tan pubescent, corolla base stipitate; surface finely striated; color shiny to dull tan.

Much of the confusion in *Melanthera* centers on this widespread, often weedy and variable taxon; problems of typification and of synonomy are discussed in the historical treatment. Because criteria for delimitation of some *Melanthera* species are not always reliable, conservative workers have tended to recognize few species; in one case a sin-

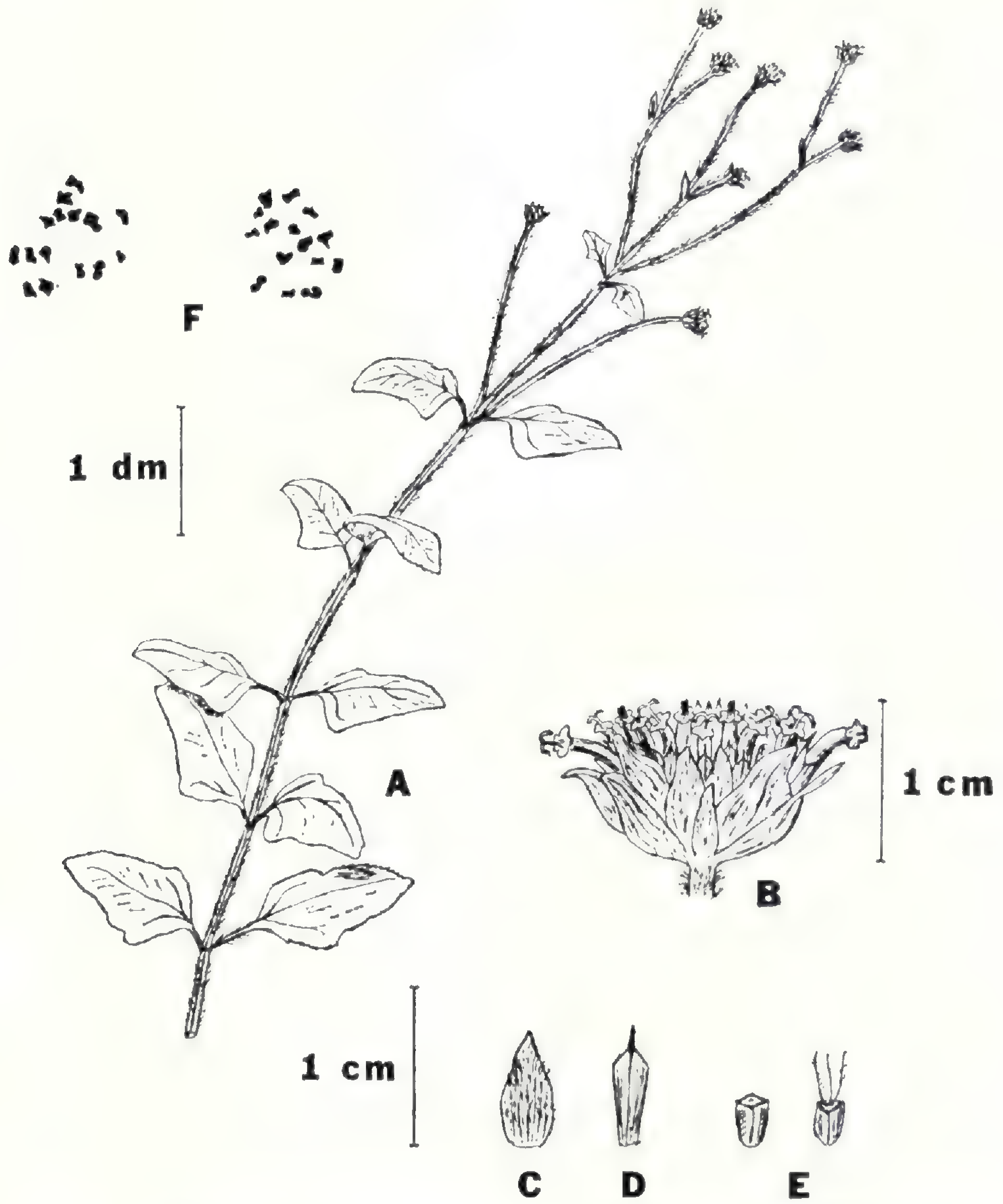


Fig. 4. *Melanthera aspera* Jacq. var. *aspera*. A. flowering branch, B. capitulum, C. phyllary, D. pale, E. achenes, F. meiotic chromosomes, late anaphase one, × 1000.

gle taxon (Standley, 1938). I believe that the two varieties of *M. aspera* treated here are reasonably distinct morphologically and ecologically and that ignoring this variability would obscure the true character of this species. While intermediates do occur, close consideration of morphology and habitat will usually enable one to determine a specimen with confidence.

2a. **Melanthera aspera** (Jacq.) Small var. **aspera.** Fig. 4.

Calea aspera Jacq., Collectanea 2: 290. 1788. Type: *Jacquin* (BM, photo. US!) Plate in Icon. Plantarum Rariorum 3: 13, t. 583. 1789.

Melananthera deltoidea Michx., Flora Bor. Amer. 107. 1803. Type: based on O. Swartz, Obs. Bot. 296. 1791.

Melananthera Linnaei H.B.K., Nov. Gen. & Sp. 4: 199. 1820. Type: ?

Melanthera corymbosa Spreng., Neue Entdeckungen 2: 135. 1821. Type: ?

Melanthera urticifolia H. Cass., *in* Levrault, F. G. (ed.), Dict. Sci. Nat. 29: 484. 1823. based on Dillenius, *op. cit.*

Amellus asper O. Kuntze vars. *normalis* et *canescens* O. Kuntze, Rev. Gen. Pl. 305. 1891. Types: ?

Melanthera buchii Urban, Symb. Antillanae 3: 411. 1903. Type: Haiti: ad Bilbaro, 700 m, *Buch* 364 n.v.

Melanthera amethystina O. E. Schulz, *in* Urban, Symb. Antillanae 7: 127. 1911. Type: not designated. Lectotype: Santo Domingo, *Turckheim* 3199b (NY!, c.f. *M. molliuscula*)

Melanthera canescens (O. Kuntze) O. E. Schulz, *l.c.* based on *Amellus asper* O. Kuntze var. *canescens* O. Kuntze, *l.c.* numerous cited specimens examined

Melanthera hastata var. *cubensis* O. E. Schulz, *l.c.* Type: not designated, Lectotype: Cuba: prope Habana, *Wright* 3608 (NY! dup. US!)

Melanthera molliuscula O. E. Schulz, *l.c.* Type: not designated, Lectotype: Santo Domingo, *Turckheim* 3199 (NY!, cf. *M. amethystina*)

Melanthera montana O. E. Schulz, *l.c.* Type: Porto Rico: San Juan, near Bayamon in montane woods, *Sintenis* 1145, ex parte, n.v.

Melanthera hastata (Walt.) L. C. Rich. spp. *cubensis* (O. E. Schulz) Borhidi, Botanikai Kozlemenyek 58: 177. 1971. based on Schulz, *l.c.*

Melanthera aspera var. *aspera* is distinguished by its coarseness and by the presence of short, often stiff, erect trichomes on stems and leaves. Its leaves are usually subcoriaceous and ovate with broadly acute bases and crenulate margins. In flower it is distinguished by broadly lanceolate phyllaries, pales with apical caudae 0.5-1.4 mm in length, corolla with a spreading limb, and by achenes with truncate to concave, sparingly pubescent apices.

Variety *aspera* grows on dry old beaches, rocky banks, and weedy fields from near sea level to 100-150 m altitude in the Greater Antilles, Florida, Mexico, and Central America (Fig. 3). Flowering in the summer and fall.

REPRESENTATIVE SPECIMENS EXAMINED. BRITISH HONDURAS: Stann Creek railway, 50 ft alt., small shrub, *Schipp* 282 (F, MICH, MO, NY, UC, US). COSTA RICA: prov. unknown, in brush, roadside, 17 km E of Turrialba, *Cronquist* 8833 (MICH, TEX, UC, USF). **Guanacaste:** Rio Liberia, NE of Liberia, alt. 100 m, *Dodge* 6243 (F, MO). CUBA: **Habana:** Santiago de las Vegas, *Baker* 4983 (F, UC, US). **Oriente:** Baracoa, *Pollard* 8 (F, MO, UC, US). DOMINICAN REPUBLIC: **Barahona:** Barahona, *Fuertes* 40B (F, MO, UC). **La Vega:** loc. unknown, *Ekman* 14122 (F, US). SANTO DOMINGO: vicinity of Ciudad Trujillo, alt. 0-25 m, *Allard* 13120, 13133, 14014, 14463 (US). EL SALVADOR: **La Union:** openings, roadside, sea level, *Beetle* 26267 (SMU, US). **Sonsonate:** Armenia, *Standley* 23443a (US). GUATEMALA: **Alta Verapaz:** damp limestone thickets, 43 km NE of Coban, *Standley* 70118 (F). **Huehuetenango:** swampy places, below Miramar, alt. 300 m, *Steyermark* 51504 (F). **Izabal:** Puerto Barrios, sea level, *Standley* 24916 (US). **Santa Rosa:** wet forested quebrada, E of Taxisco, alt. 225 m, *Standley* 79007 (F). HAITI: dept. unknown: Cap Haitien, *Leonard* 5308 (US); **Port au Prince,** Morne l'Hospital, alt. 350 m, *Holdridge* 1037 (F, MICH, US). HONDURAS: **Atlantida:** stream bank thicket, foothills of Ceiba, *Yuncker* 8266 (MICH, MO, NY). **Comayagua:** moist thickets, Siguatepeque, alt. 1050 m, *Standley* 6717 (F). **Olancho:** mimosa thickets, 400 m alt., Juticalpa, *Standley* 17762 (F). JAMAICA: parish unknown, Lititz

Savanna, alt. 300-900 ft, *Harris* 11739 (F, MO, US). MEXICO: **Jalisco:** cultivated areas W of airport, sea level, *Feddema* 2547 (MICH). **Oaxaca:** near Totontepec, alt. 3700-5500 ft, *Nelson* 819 (US). **Vera Cruz:** near Cordoba, *Greenman* 152 (F). **Yucatan:** Izamal, *Gaumer* 404 (DS, F, MICH, MO, NY, PH, UC, US). NICARAGUA: dept. unknown: dry bushy slope, sierras de Managua, alt. 400 m, *Grant* 950 (F, MICH). **Matagalpa:** Santa Maria de Ostuma, alt. 1200-1500 m, *Heller* 68 (F). PANAMA: Bocas del Toro: Almirante, roadside, *Blum* 1319 (FSU, MO). **Canal Zone:** Ft. Clayton, old Las Cruces Trail, *Standley* 29008 (US). **San Blas:** Irandi airport, *Duke* 6516 (MO). **San Jose Is.:** *I. Johnston* 1100 (US). PUERTO RICO: Arecibo: roadside herb, Florida, *Wagner* 94 (DUKE, MO). **Mayaguez:** sandy soil near Mayaguez, alt. 350 m, *Holm* 170 (MO). TRINIDAD: St. Ann's Cascade, *Broadway* 5147 (F, MO). UNITED STATES: **Florida:** BREVARD CO., Hammock, Merritt's Island, *Small* 9437 (GH, MICH). COLLIER CO., roadside by the gulf, Naples, *Parks* 124 (DS, DUKE, EVG, F, FLAS, FSU, GA, GH, MICH, MO, NCU, MCSC, NY, PAC, PH, SMU, UC, US, VDB, WIS). DADE CO., hammocks on sand dunes, Lemon City, *Small* 5821 (DUKE, FLAS, MO, NCU, NY, US). LEE CO., waste places, Sanibel Is., *Cooley* 2515 (FLAS, GH, NY, US, USF). MANATEE CO., Palmetto, *Nash* 2433 (F, GH, MICH, NCU, MO, NY, US). MARTIN CO., one pt., open sand on new levee, Port Mayaca, *Parks* 83 (VDB). PINELLAS CO., sandy soil, Maximo Pt., *Thorne* 15430 (GH).

2b. **Melanthera aspera** (Jacq.) Small var. **glabriuscula** (O. Kuntze) Parks, comb. nov. Fig. 5.

Amellus asper O. Kuntze var. *glabriusculus* O. Kuntze, Rev. Gen. Pl. 305, 306. 1891. Lectotype: Panama: Colon, *O. Kuntze* (NY!)

Melanthera brevifolia O. E. Schulz, *in* Urban, Symb. Antillanae 7: 123. 1911. Type: not designated, Lectotype: Florida: Monroe Co., Elliot's Key in arenosis maritimis, *Curtiss* 1415 (US! dup. F! MISSA! NY! PH!)

Melanthera crenata O. E. Schulz, *l.c.* Type: not designated, Lectotype: Bahamas, New Providence, *J. & A. Northrop* 58 (NY!)

Melanthera calcicola Britton, Sci. Survey Puerto Rico and the Virgin Islands **6**(1): 309. 1925. Type: Puerto Rico, *Britton* 6784 (NY!)

Melanthera confusa Britton, l.c. Type: Virgin Is.: Tortola, *Fishlock* 440 (NY!)

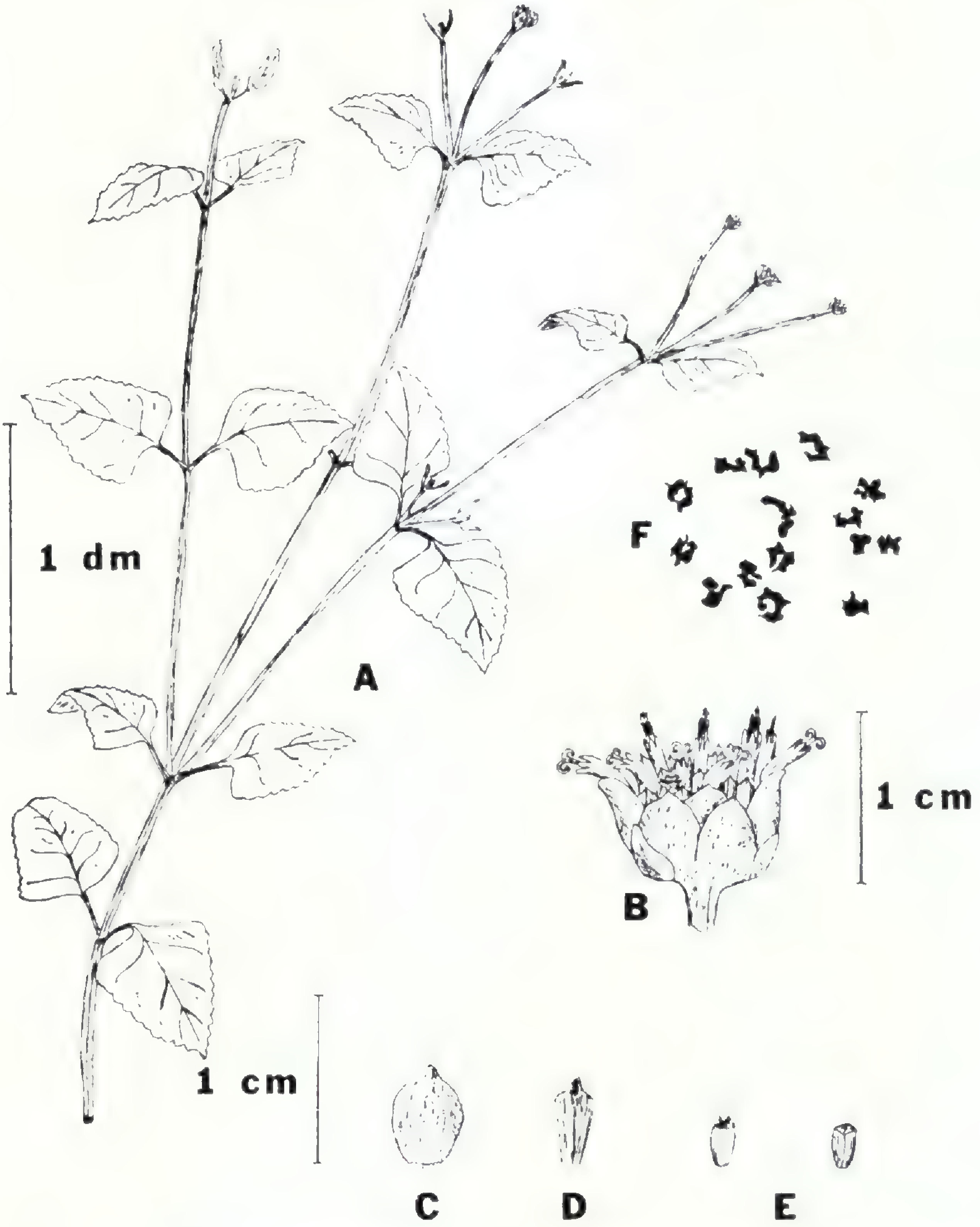


Fig. 5. *Melanthera aspera* Jacq. var. *glabriuscula* (Ktze.) Parks. A. flowering branch, B. capitulum, C. phyllary, D. pale, E. achenes, F. meiotic chromosomes, metaphase one, × 1000.

This variety is glabrescent with appressed-ascending hairs on stems and leaves. The leaves are ovate to deltoid, membranaceous, light green, and with crenate margins. The capitulum is 1.2 cm or less in diameter; the phyllaries are broadly ovate, subequal and only slightly exceed the disc at first anthesis; the apical caudae of the pales is 0.5 mm or less in length; the corolla limb is usually ascending; the style branches usually recurve upon themselves when senescent; the achenes are smaller than in the typical variety being 2.0-2.5 mm long, apex usually convex and tan-pubescent.

Kuntze (1891) cited no specimens with his descriptions, but his itinerary fits well the location and time noted on the specimen I have designated as lectotype. Possibly, duplicates of this specimen were deposited at Berlin and Kew.

This variety grows high on beaches throughout the Caribbean and on the mainland of southern Florida, Mexico, and Central America (Fig. 3).

REPRESENTATIVE SPECIMENS EXAMINED. BAHAMAS: mangrove bay, Andros, *Brace* 4886 (F); Long Is., beach near dock, Clarence Town, *Hackett* 136 (DUKE, MICH, UC); **South Bimini**, cleared land near dock, *Hackett* 87 (DUKE, LAF, MICH, UC, US, USF). CUBA: **Camaguey**, near Pueblo Romano, Cayo Romano, *Shafer* 2453 (F, US). **Habana:** high on sandy beach, Playa Baracoa, *Sauer* 1770 (WIS). HONDURAS: **Atlantida:** near beach, Salado, *Yuncker* 8329 (F, MICH, MO). JAMAICA: **Portland:** Long Bay, *Adams* 7586 (DUKE). **Westmoreland:** scrub woodland near lighthouse, West Pt., *Webster* 6067 (MICH). LESSER ANTILLES: **Antigua**, seashore, *Box* 1157 (F, MICH, MO, US); **Barbados:** Christchurch Parish, in dunes, *Sauer* 2185 (F); **Grand Caymen**, Georgetown, *Armour* 1395 (F); **Grenada**, wayside, levera, *ign.* 1268 (US); **Guadeloupe**, *Griesbach* Dec. 1857 (MO); **Martinique**, alt. 40 m, *Stehle* 5125 (US); **Virgin Is.**, St. Thomas, *Delanses* 1845 (F). MEXICO: **Quintana Roo:** Cozumel Is., *Gaumer* Aug. 1886 (US). **Yucatan:** Izamal, *Gaumer* 15543 (WIS). PANAMA: **Bocas del Toro:** Bocas del Toro, *Carleton* 154 (US). **Canal Zone:** Ft. Sherman, bathing beach, *Tyson* 2263 (FSU, MO). PUERTO RICO: **Aguadilla:** roadside, Lares, *Liogier* 9956 (DUKE, FPDB, US). **Culebra Is.:** Southshores, *Armour* 627 (F). **Humacao:** coastal bank, Playa de Fajordo, *Britton* 1592 (F, US). TRINIDAD: upper beach, Manzanilla Bay, *Sauer* 2249 (F). UNITED STATES:

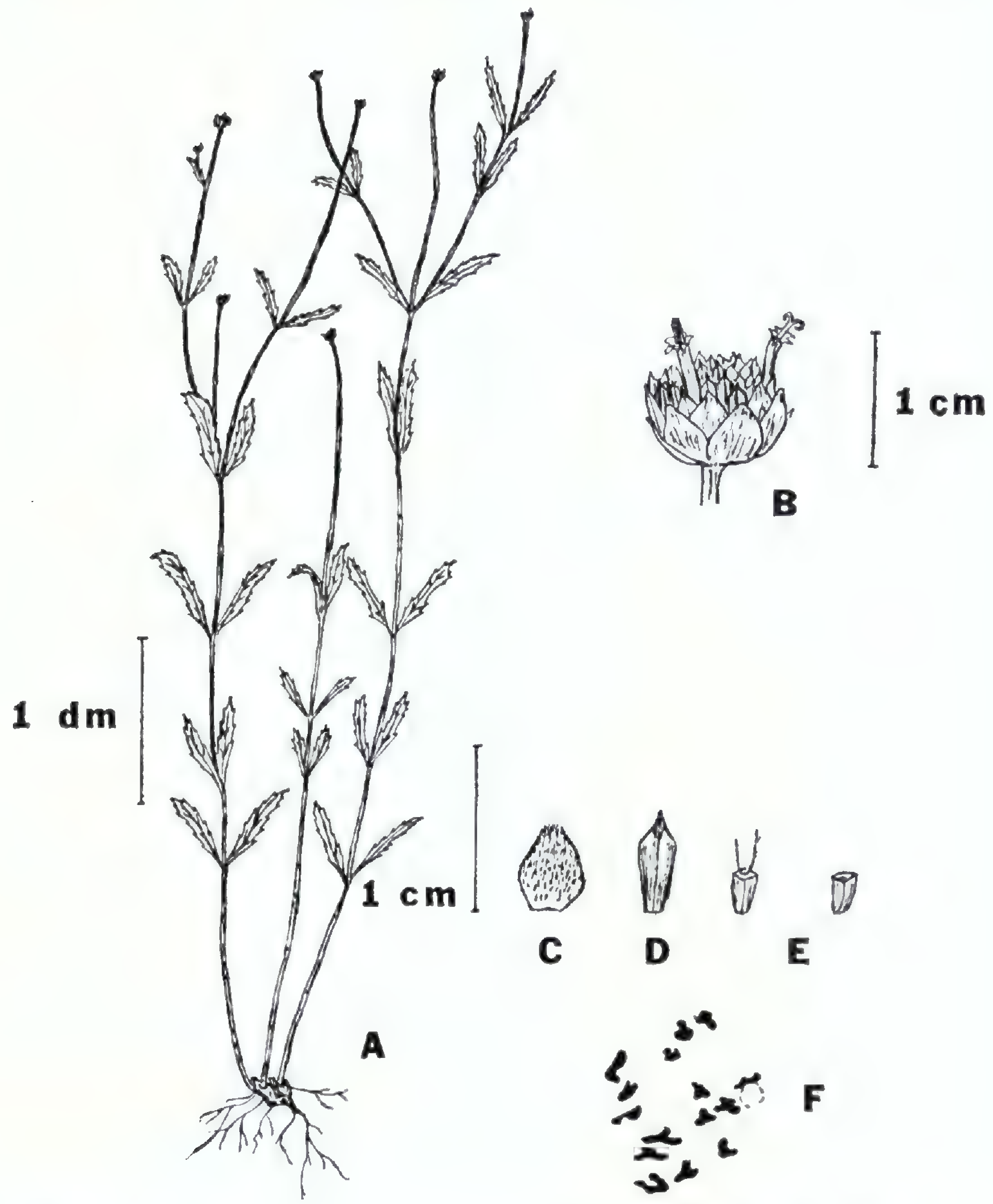


Fig. 6 *Melanthera angustifolia* A. Rich. A. habit sketch, B. capitulum, C. phyllary, D. pale, E. achenes, F. meiotic chromosomes, diakinesis, × 1000.

Florida: BROWARD CO., Sandy soil, Lauderdale beach, *Moldenke* 262 (DUKE, MO, NY). Collier Co., sand island, Everglades City, *Parrott* 189 (DUKE). DADE CO., coral rock, Totten Key, *Cooley* 9343 (USF). LEE CO., weedy on shell mound, Bird Is., *Brass* 18092 (US). MONROE CO., beach, Bradley Key, off East Cape, *Parks* 274 (EVG, F, US, VDB); Long Key, common high on ocean beach, *Parks* 283 (GA, MICH, NCSC, NCU, PAC, VDB); Marquesas Key, *Lansing* 2116 (F, NY).

3. **Melanthera angustifolia** A. Rich., *in* Sagra, R., Hist. Isla Cuba **11**: 54. 1850. Fig. 6. Lectotype: Cuba: Isla de los Pinos: *La Sagra* (P)

Melanthera lanceolata Benth. ex Oerst., Kjoeb., Vidensk. Meddel. 88. 1852. Type: Coll. & date not ascertained (BM, photo & fragment US!)

Melanthera microphylla Steetz, Bot. Voy. Herald 156. 1854. Type: Panama, *Seemann* 254 (photo US!)

Melanthera linearis Blake, Contr. U.S. Ntl. Herb. 24: 30. 1922. Type: Guatemala: Izabal: Cristina, R.R. ditch, *Blake* 7601 (US!)

Melanthera purpurascens Blake, Contr. U.S. Ntl. Herb. 22: 629. 1924. Type: Mexico: Chiapas: tableland about Ocuilapa, *Nelson* 2995 (US!)

Melanthera angustifolia A. Rich. var. *subhastata* O. E. Schulz, Report Sp. Nov. **26**: 109. 1929. Type: Cuba: *Ekman* 12359 (NY!)

Weakly erect perennial herb, 3-9 dm tall, arising from a woody usually buried rootstock. Stems several, slender, 3-9 dm tall, 2-3 mm in diameter, quadrangular, mostly red-maroon. Leaves lanceolate-oblanceolate-linear, rarely narrowly ovate-elliptical, 3-8 cm long, 0.5-1.5 cm wide, length-width ratio av. 8; base cuneate to attenuate; apex acute; margin irregularly serrate-serrulate; pubescence sparse, appressed-ascending. Capitulum solitary, terminal borne on a slender, sulcate, glabrescent, usually long (9-20 cm) peduncle; involucre of one to two subequal series, 0.6-1.2 cm in diameter; phyllaries ovate, 4-5 mm long, 2-3 mm wide, length-width ratio av. 1.5, the apical 1/4-1/3 green, pubescence appressed-ascending; pales oblanceolate, 4-5 mm long, 1 mm wide, aristae 0.5 mm long. Neither

floret nor fruit is distinctive. They resemble those of *Melanthera ligulata* but fewer of each are present in the *M. angustifolia* capitulum.

Melanthera angustifolia seems to frequent low, moist to swampy, lightly shaded areas but is apparently found in drier situations in parts of its range. Distributed from southern Florida, through western Cuba and the Isle of Pines into Yucatan, southeastern Mexico, and Central America (Fig. 3), it is sparsely collected throughout its range and is nowhere a common plant. It flowers from mid to late summer.

Achille Richard did not designate a type specimen for this taxon. However, Dr. Alicia Lourteig of the Museum of Natural History, Paris (P), has informed me (personal correspondence) that a specimen exists there labeled in the author's hand as noted above. In light of the supporting evidence, it seems reasonable to designate this sheet as the lectotype of the distinctive *Melanthera angustifolia.* (For additional discussion see Jennings, 1917.)

Melanthera angustifolia is usually considered one of the most distinct species in the genus. Unfortunately, this assumption is based solely on the unstable character of leaf shape. Occasional specimens of *M. nivea* exhibit lanceolate leaves, as do *M. parvifolia* and *M. ligulata.* While the type specimens of *M. lanceolata* and *M. purpurascens* are somewhat extreme in leaf characters, other traits indicate that they are best considered synonyms of *M. angustifolia.*

REPRESENTATIVE SPECIMENS EXAMINED. CUBA: **Camaguey:** Airoyo, *Britton* 13133 (US). **Isle of Pines:** savannahs, road to San Francisco de las Piedros, *Killip* 45440 (US). DOMINICAN REPUBLIC: **Puerto Plata:** coastal swamp, Cabarete, *Ekman* 14537 (F, US). SANTO DOMINGO: in savannas, *Ekman* 13323 (F). GUATEMALA: **Alta Verapaz:** slopes near coves, SW of Lanquin, *Steyermark* 44027 (F, US). **Izabal:** dry pine slopes, Izabal, alt. 65-600 m, *Steyermark* 38559 (F). **Peten:** La Libertad, *Aguilar* 4 (MICH, MO, NY, US). HAITI: prov. unknown, Pearice, Ramielle, *Ekman* H6244 (US). MEXICO: **Tabasco:** Tenosique, in savanna, *Matuda* 3502 (F, MICH, MO, NY, UC). **Vera Cruz:** meadow in oak forest, SE of Catemaco, *Dressler* 122 (F, MICH, MO, NY, UC, US); E of Tuxpan,

toward La Playa, *Strother* 541 (SMU, TEX). PANAMA: **Panama:** Los Sabanas, open slope near sea level, *Standley* 40777 (US). UNITED STATES: **Florida:** BROWARD CO., rocky, calcareous land, Ft. Lauderdale, *Curtiss* 5846 (DS, F, FLAS, GA, GH, MO, NCU, NY, PAC, SMU, UC, US). COLLIER CO., pine-palmetto flatwood on lime rock, Monroe Sta., *Parks* 298 (EVG, F, FSU, MICH, NY, PAC, SMU, US, VDB, WIS); Tamiami Trail near Naples, *Horner* 22 Dec. 55 (WIS). DADE CO., everglades, Camp Longview, *Small* 1790 (NY); burned pine flatwoods on limestone, 3 mi N of Rock Reef Pass, *Godfrey* 63420 (FLAS, FSU); 3 mi W of Everglades Ntl. Park entrance, open glades, *R. Smith* 643 (NCU); wet, marly prairie, Grossman Hammock, *Webster* 10261 (DUKE); rocky pineland, Long Pine Key, *Scull* 18 Mar. 40 (FLAS). MONROE CO., Pinecrest rd., Cypress ponds, pinelands, ditches, *Lakela* 29894 (USF). PALM BEACH CO., sandy peat in pine flatwoods, NW of Loxahatchee, *Kral* 5642 (FSU, SMU, VDB).

4. **Melanthera parvifolia** Small, Flora SE. United States 1251, 1370. 1903. Fig. 7. Type: Florida: (Monroe Co.), Big Pine Key, *Blodgett, s.n.* (NY! isotype GH!)

Melanthera radiata Small, Bull. Torrey Bot. Club **36:** 163. 1909. Type: Florida: Dade Co., Camp Longview, *Small & Wilson* 1575 (NY!)

Melanthera hastata var. *parvifolia* (Small) O. E. Schulz, *in* Urban, Symb. Antillanae **7:** 126. 1911. based on Small *l.c.*

Suffrutescent perennial, 3-6 dm tall, sprawling to weakly erect with numerous, sparingly branched stems arising from large hemispheric, caudex-like, woody rootstock. Stems slender, obscurely 4 angled, green with a dark red tinge, rarely red; indument strigose to hirsute. Leaves ovate, 1.5-4 cm long, 1-1.5 cm wide, moderately coreaceous, rich, dark green; base broadly acute to obtuse, hastate or ascending basal lobes common, petiole very short; apex acute; margin coarsely serrate, sometimes undulate, basal teeth may be large, salient or ascending; indument strigose to hispid. Capitulum solitary, terminal, borne on a slender, sulcate, hispid to strigose peduncle which is 2.5-10 cm long; involucre in two loosely imbricate series, 1-1.4 cm in diameter; phyllaries lanceolate, 5-7 mm long, 1.5-3 mm wide, length-width ratio av. 2.5, tip often recurved, notice-

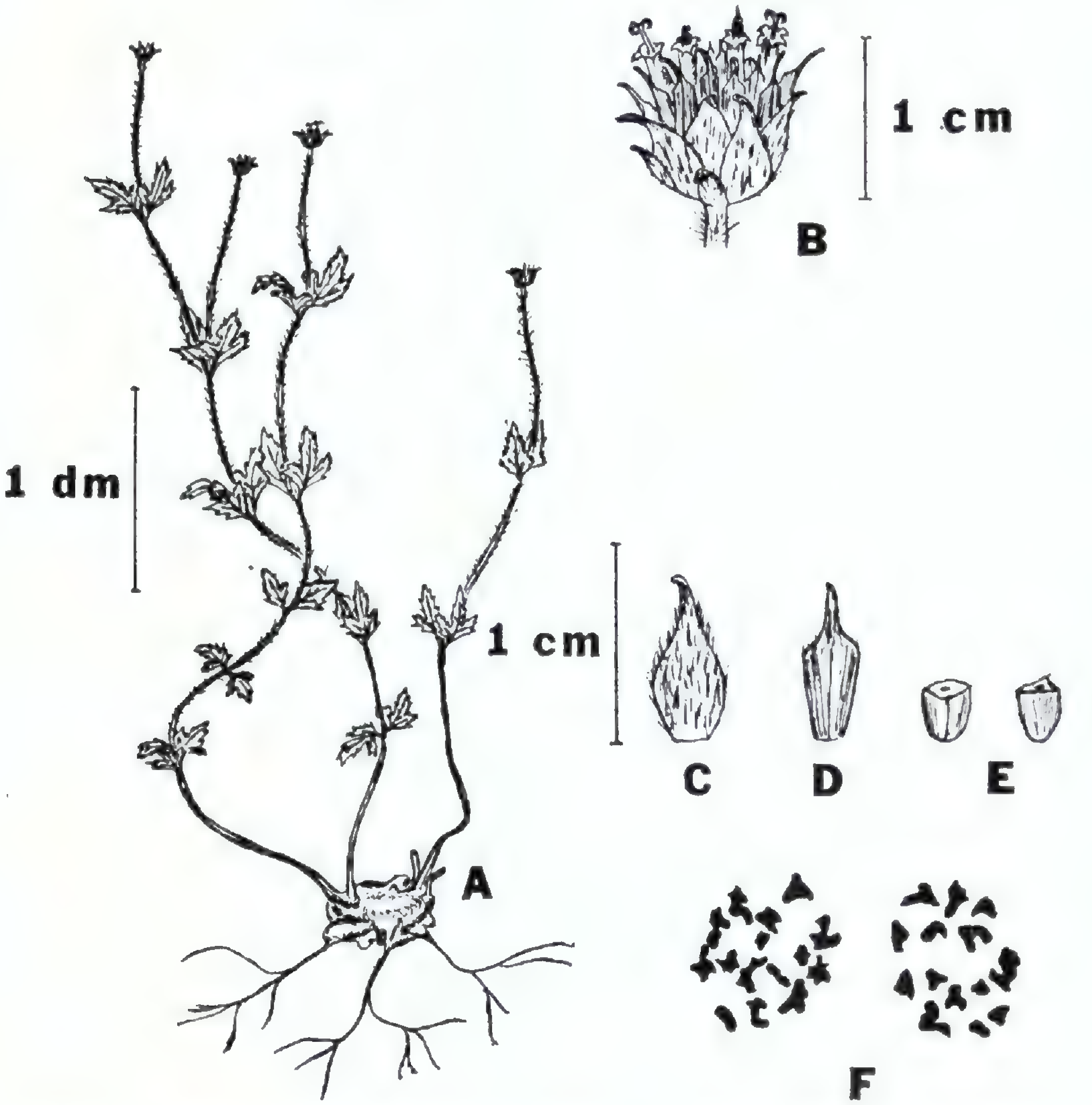


Fig. 7. *Melanthera parvifolia* Small. A. habit sketch, B. capitulum, C. phyllary, D. pale, E. achenes, F. meiotic chromosomes, late anaphase one, × 1000.

ably longer than florets at first anthesis, green for ¾ length apically, pallid basally, pubescence of short, erect-ascending trichomes, abundant marginally and abaxially; pales oblanceolate 6-7 mm long, 2 mm wide, strongly keeled, apical aristae 1-1.5 mm long, often recurved, numerous hairs present on the upper, abaxial surface. Corolla tube 4 mm long, some hairs present; corolla limb 0.5 mm long, spreading, papillate adaxially, strigillose abaxially; anther sacs 1.5 mm long; style branches 1.2 mm long, apex slightly sagittate, drawn out into an unusually long, slender, pubescent tip. Achene obpyramidal, 2.5-3 mm long, 1.5-2 mm wide; apex truncate, margin may be cuspidate or crowned, apical hairs sparse; surface finely striated, lustrous, dark brown.

Old coral reefs or porous oolitic rock, Big Pine Key and the everglades keys, southern Florida. Flowers throughout the summer. Fig. 3.

This rather diminutive, endemic species is quite distinct. It is perhaps most easily recognized by its sprawling or bushlike habit and its large, knobby root. The achenes and capitula of this species are, proportionally, fairly large while the number of florets per capitulum is small. Anomalous plants, likely a result of introgression from *Melanthera angustifolia*, may exhibit slightly smaller capitula with broadly lanceolate phyllaries. Plants growing on Big Pine Key are a bit different morphologically, having spreading rather than flat margins.

REPRESENTATIVE SPECIMENS EXAMINED. UNITED STATES: **Florida:** BROWARD CO., near new River Canal, S of Lake Okeechobee, *Small* 4441 (DUKE, FLAS, GH, NCU, NY). COLLIER CO., dry sandy pineland, E Naples, *Moldenke* 24160 (WIS). DADE CO., pinelands, Addison's Hammock, *Small* 6639 (NY); cut pineland over limestone, Bauer Hammock, *Webster* 10115 (DUKE); hammocks, Black Pt. Creek, *Small* 5970 (MO, NCSC, NY); dry, sandy soil, Buena Vista, *Moldenke* 309 (DUKE, MO, NY); 8 mi W of Everglades Ntl. Park inf. center, pinewoods, *Parks* 112 (EVG, F, FSU, GH, MO, NY, PAC, SMU, US, VDB, WIS); thin soil over old coral reef, Florida City, *Kral* 12044 (VDB); pine-palmetto woods, Grossman Rd, *Parks* 291 (EVG, PAC, US, VDB); pinelands over limestone, Homestead, *Brass* 21149

(GH), *Godfrey* 65609 (LAF, NCU, USF); vacant lot behind Tradewinds Motel, *Parks* 109 (DUKE, EVG, F, FSU, GH, MO, NY, PAC, SMU, US, VDB, WIS); pinelands, Inlikita, 8 mi N of Homestead, *Parks* 113 (EVG, F, FSU, NY, PAC, SMU, US, VDB); rocky land, Miami, *Curtiss* 5851 (DS, F, FLAS, GA, GH, MO, NCU, NY, PAC, SMU, UC, US); NW 54th St. & 27th Ave. Miami, *C. & J. Javish* 535 (DS, MO); pinelands, Murden Hammock, *Small* 6439 (NY), 6450 (MO, NY); Nixon-Lewis Hammock, *Small* 7351 (DUKE, NCU, NY). MONROE CO., open hammock, Big Pine Key, *Brown* 128 (NY, PH); pine-palmetto woods, Big Pine Key, *Killip* 40217 (DS, GA, US); pine-palmetto woods, end of Rt. 940, Big Pine Key, *Parks* 289 (EVG, SMU, US, VDB); hammocks, Boca Chica Key, *Small* 3918 (NY); Key West, *Chapman s.n.* (NY); Long Key *Frost* 8 Feb. 1931 (PAC); Old Rhode's Key, *Small* 6 Nov. 1901 (NY).

5. **Melanthera ligulata** Small, Bull. New York Bot. Gard. 3: 439. 1905. Fig. 8. Type: Florida: Broward Co., pinelands below Ft. Lauderdale, 1904, *Small & Wilson* 1775. (NY!)

Suffrutescent, often luxurious perennial, 3-9 dm tall, arising from a slightly swollen root. Main axis decumbent, freely branched at the jointed nodes, sulcate to obscurely quandrangular, usually reddened or red-mottled on upper surfaces, glabrescent. Leaf shape highly variable, ovate-elliptical-lanceolate forms often on the same plant, 4-12 cm long, 1-4 cm wide, noticeably triple-nerved, commonly light green, glabrescent; base acute-cuneate, obtuse or hastate, commonly basal lobes strongly ascending; apex acute, margin serrate, lanceolate leaves saliently and irregularly toothed. Capitulum mostly solitary, terminal, borne on a sulcate, glabrescent peduncle 6-14 cm long; involucre in two loosely imbricate series 1.2-1.4 cm in diameter; phyllaries lanceolate, 5-7 mm long, 2 mm wide, dark green for 2/3-3/4 length apically, pallid basally with obscure nerves, pubescence short, appressed-ascending, phyllaries often noticeably longer than florets at first anthesis and recurved; pales oblanceolate, 6-7 mm long, 2 mm wide, apical aristae about 1 mm long, may be recurved. Corolla tube 4.5 mm long; limb spreading, 1 mm long, papillate adaxially. Anther sacs 2 mm long; style branches 1.5 mm long, may completely recurve when senescent. Achene not dis-

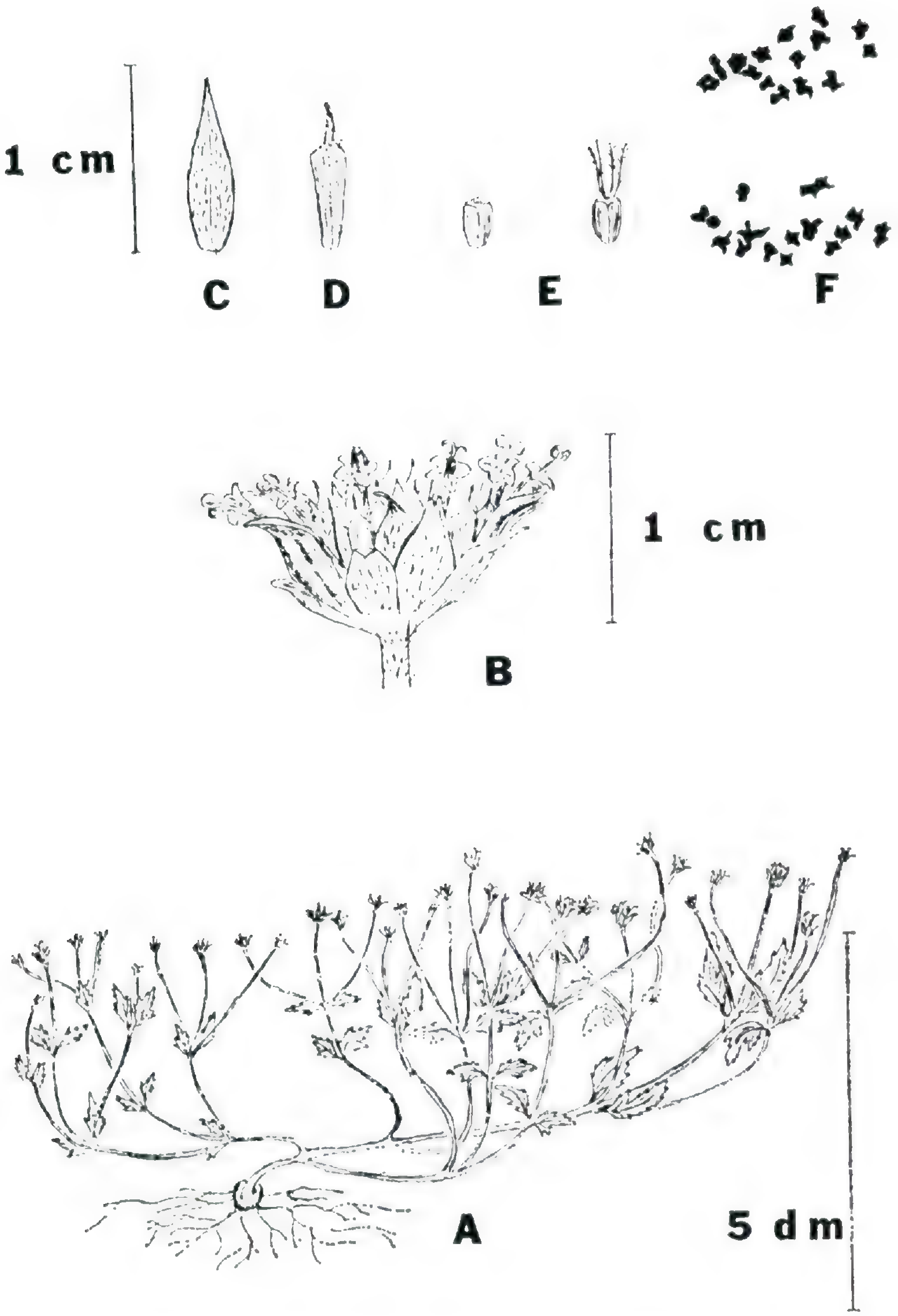


Fig. 8. *Melanthera ligulata* Small. A. habit sketch, B. capitulum, C. phyllary, D. pale, E. achenes, F. meiotic chromosomes, late anaphase one × 1000.

tinctive, obpyramidal, 2.5 mm long, 1.5 mm wide; apex truncate to slightly concave, with short, tan to white hairs at maturity; color dull tan.

Pine-palmetto flatwoods, usually in sun, from central to southern Florida. Flowers in early summer. Fig. 3.

This species of *Melanthera* is sparingly represented in herbaria and most of the specimens available have not been properly identified. It has not been well understood partly because it is restricted, largely to inaccessible areas such as the region south of Lake Okeechobee, and partly because the original circumscription is too narrow. As a result of my field observations in southern Florida, it became evident that certain anomalous plants seen were probably *M. ligulata.* I have included the considerable variability expressed by the leaves in the description.

Melanthera ligulata is easily recognized in the field by its decumbent stem which is profusely branched from the slightly swollen nodes. On herbarium specimens, one must note the stem characters, a generally glabrous vesture, and the capitulum which is similar to, but a bit smaller than that of *M. nivea.*

SPECIMENS EXAMINED. UNITED STATES: **Florida:** county unknown, South Florida, *Chapman* 63 (US). BROWARD CO., roadside, Ft. Lauderdale, *Crevasse* 23 July 1940 (FLAS); low pineland, Hammondville, *Brown* 16 March 1928 (FLAS). CHARLOTTE CO., Cabbage Hammock, *Frye* 181 (FLAS); pasture, *Parrott* 90 (DUKE). CITRUS CO., moist soil on limestone, 8 mi SW of Inverness, *Kral* 7891 (FLAS, GH, VDB). COLLIER CO., roadside spoil heap, 5.5 mi N of Rt. 41 on Rt. 79, *Parks* 308 A&B (EVG, F, FSU, GA, MICH, NCSC, NCU, NY, PH, SMU, US, VDB); roadsides in glades, *Brass* 15408 (US); East Henson Marsh, Big Cypress, *Brass* 15960 (US); bank sloping to swamp, intersection Rts. 29 & 82, Immokalee, *Lakela* 27442 (SMU, USF), *Parks* 310 (DS, DUKE, EVG, F, FSU, GH, MO, NY, PAC, SMU, UC, US, VDB, WIS); between Miles City & Immokalee *Seymour* 5177 (FLAS); ranchlands with cypress heads, Collier-Hendry Co. line, Rt. 846, *Lakela* 28959 (USF); railroad gravel, 10 mi N of Jerome, *Godfrey* 61003 (FSU); wet glade, W of Miles City, *Lakela* 29344 (USF); roadside, Tamiami Trail, *Atwater* M237 (EVG, FLAS). DADE CO., pinelands near Camp Longview, *Small* 13 May 1904 (GH, US) (Sheet at US later labeled as no. 1575, type of *Melanthera radiata* is *M. ligulata*), *Small* 1807 (NY); Miami,

Garber 1 May 1877 (FLAS, NY, PAC); everglades, Miami, *Small* 1764 (NY); Tamiami Trail, *W. M. R.* 15 Feb. 1935 (NY). GLADES CO., roadsides on prairie, Palmdale, *Brass* 15449 (GH, US). HENDRY CO., weedy in burned live oak hammock, Ft. Denaud, *Brass* 20623 (US); roadside, 4 mi W of Labelle, *Henderson* 63-1608 (FSU, TEX). HILLSBOROUGH CO., border, wet woods, Tampa, *Britton* 39 (NY). LEE CO., near swamp, Alva, *Francis* 152 (US); flatwood ponds, Ft. Myers, *Hitchcock* 157 (F, GH, MO, NY, US); pineland, 8 mi SE of Ft. Myers, *J. Standley* 452 (F, GH, MO, US); dooryard, near Ft. Myers, *Standley* 19024 (US); prairies near Okaloacoochee slough, *Small* 8305 (NY). OSCEOLA CO., swamp, *Fredholm* 6100 (NY); pineland, Kissimmee, *Singeltary* 167 (DUKE, NCSC). PALM BEACH CO., sandy soil, 2 mi N of Canal Pt., *Moldenke* 252 (NY); Lake Worth, *Beardslee* Dec. 1928 (UC), *O'Neill* 831 (US); dry, sandy, pine-palmetto flatwoods, Loxahatchee, *Parks* 89 (DS, DUKE, EVG, F, FLAS, FSU, GA, GH, MICH, MO, NCSC, NCU, NY, PAC, PH, SMU, UC, US, VDB, WIS), *Parks* 90 (SMU, VDB), 91 (VDB), 92 (EVG, PAC, SMU), 93 (FSU, US), 237 (DS, DUKE, F, GA, MO, NCSC, NY, PAC, PH, SMU, US, VDB, WIS). PINELLAS CO., sandy soil, rare, St. Petersburg, *Mrs. C. Deam* 2888 (US), 2898 (US). POLK CO., moist, open woods, Kissengens Spring, *Correll* 6295 (DUKE, NCSC), *McFarlin* 3033 (MICH). SUMTER CO., Esperawell, *Smith* 18 March 1879 (US).

DOUBTFUL OR EXCLUDED SPECIES

Melanthera fruticosa Brandgee, Univ. California Publ. Bot. **10**: 421. 1924. = *Philactis Liebmanii* (Klatt) Blake, Contr. Gray Herb. *n.s.* 52: 35. 1917. Type: Mexico: Chiapas: near Tuxtla along rocky road, *Purpus* 9117 (US!, isotypes MO! NY! US!) Having examined the type collection, I concur with the treatment of Torres (1969).

Melanthera hastifolia Blake, Contr. U.S. Ntl. Herb. **24**: 29. 1922. Type: Guatemala: Izabal: near Cristina in ditch along railway, *Blake* 7601A (US!, isotype US!). Only one collection other than the type collection was available for examination, *Lundell* 4928 at MICH, US, NY. These were determined by Blake, but are not like the type material and seem to represent *M. aspera*. I believe the type collection of *M. hastifolia* probably represents elements of a hybrid swarm, with the putative parents being *M. angustifolia* and *M. nivea*.

Melanthera parviceps Blake, Jour. Washington Acad.

Sci. 22: 384. 1932. Type: British Honduras: El Cayo District: in ravine, Little Mountain Pine Ridge, *Bartlett* 11882 (US!, isotypes F! UC!) I have seen only four herbarium specimens of this taxon, all from the same locality and three from the type collection. *Melanthera parviceps,* on the basis of these few specimens, appears rather distinctive. Although similar to *M. aspera* var. *glabriuscula* in capitulum characters, the heads of *M. parviceps* are more numerous, smaller, and bear fewer florets. Also the peduncles and phyllaries are strongly hispid to hirsute. Vegetatively the plant seems to resemble *M. nivea,* with the leaves being mostly narrowly ovate with divergent hastate lobes. Until more collections become available, I prefer to place this as a dubious species, rather than to recognize it, or reduce it to *M. aspera* var. *glabriuscula.*

ACKNOWLEDGEMENTS

I wish to thank Dr. Robert Kral of Vanderbilt University for suggesting this problem and, as major professor, for offering suggestions and guidance instrumental in its solution. I also thank the late Dr. Lloyd H. Shinners of Southern Methodist University, Drs. William T. Stearn and J. E. Dandy of the British Museum, Dr. Alicia Lourteig of Paris, and Dr. Richard Howard of the Arnold Arboretum for their aid with various aspects of the nomenclature. Dr. Frank C. Craighead Sr. helped with field work in Everglades National Park. The graciousness of the various curators who provided valuable herbarium materials for study is also acknowledged. I am indebted to my wife Vicki for her continuous and real help in all aspects of this investigation. This work was based, in part, on a dissertation submitted to the Department of General Biology, Vanderbilt University, in partial fulfillment of the requirements for the Ph.D. degree. It was supported by a National Defense Education Act Graduate Fellowship to the author.

LITERATURE CITED

ADANSON, M. 1763. Familles des Plantes. Paris: Vincent. 2: 131.

ANDERSON, E. 1949. Introgressive Hybridization. New York: John Wiley & Sons. 109 pp.

BENTHAM, G. & J. D. HOOKER. 1873. Genera Plantarum. London: Reeve & Co. 2: 377.

BLAKE, S. F. 1922. New plants from Guatemala and Honduras. Contr. U.S. Ntl. Herb. 24: 29-30.

———. 1924. New American Asteraceae. Contr. U.S. Ntl. Herb. 22: 628-629.

———. 1930. Notes on certain type specimens of American Asteraceae in European herbaria. Contr. U.S. Ntl. Herb. 26: 254.

———. 1932. New Asteraceae. Jour. Washington Acad. Sci. 22: 384-385.

BRITTON, N. L. & P. WILSON. 1925. *in* Scientific Survey of Porto Rico and the Virgin Islands. New York Acad. Sci. 6: 308-310.

BROWN, R. 1817. Observations on the natural family of plants called Compositae. Trans. Linn. Soc. London. 12: 107-112.

BROWNE, P. 1756. The Civil and Natural History of Jamaica (ed. 1). London: Osborne. 503 pp.

CARLQUIST, S. 1965. Island Life. A Natural History of the Islands of the World. Garden City: Natural History Press. 451 pp.

CASSINI, H. 1823. *in* Levrault, F. G. (editor), Dictionnaire des Sci. Nat. Strasbourg & Paris. 29: 483-497.

CHANEY, R. 1947. Tertiary centers and migration routes. Ecol. Monogr. 2: 139-148.

COULTER, J. 1891. New or noteworthy Compositae from Guatemala. Bot. Gaz. 16: 100.

CRONQUIST, A. 1955. Phylogeny and taxonomy of the Compositae. Amer. Midland Nat. 53: 478-511.

CRUXENT, J. & I. ROUSE. 1969. Early man in the West Indies. Sci. Amer. 221: 42-52.

DANDY, J. 1969. Nomina conservanda proposita. (proposal 286). Taxon. 18: 470.

DILLENIUS, J. 1732. Hortus Elthamensis. London. 437 pp.

GAERTNER, J. 1791. Fruct. 2: 456.

JACQUIN, N. 1788. Collectanea —. Vindobonae: Wappler. 2: 290.

JENNINGS, O. 1917. Contributions to Botany of the Isle of Pines, Cuba. Annals Carnegie Museum. 11: 286.

KUNTZE, O. 1891. Reviso Generum Plantarum. Leipzig. 1011 pp.

LANJOUW, J. (Chief ed.) & F. STAFLEU (Sec.) 1966. International Code of Botanical Nomenclature. Utrecht: Kemink & Zoon. 402 pp.

LINNAEUS, C. 1753. Species Plantarum. (reprint 1957, Ray Society, London). 2: 833.

————. 1759. Systema Natura (ed. 10). Stockholm.

————. 1759. Amoenites Academie. Uppsala. 5: 371-388.

MICHAUX, A. 1803. Flora Boreali-Americana. Paris & Argentorati: Levrault. 2: 107.

MILLSPAUGH, C. 1907. Flora of the sand keys of Florida. Publ. Field Museum Nat. Hist. 2: 191-245.

POWELL, A. & B. TURNER. 1963. Chromosome numbers in the Compositae VII. Additional species from the southwestern United States and Mexico. Madrono. 17: 128-140.

RICHARD, A. 1850. *in* La Sagra, de Ramon. Historia Fisica, Politica y Natura de la Isla de Cuba. Paris: Maulde & Renou. 11: 54.

ROHR, J. VON. 1792. Plantae-Slaegter poa St. Croix. med tilfoiede Anmaerkninger af Vahl. Skriv. Nat. Selsk, (Kiobenhaven). 2: 205-227.

SCHULZ, O. E. 1911. Compositarum Genera Nonnulla. *in* Urban, I., Symbolae Antillanae. 7: 115-127.

SCHWEGMAN, J. 1968. New plant records from southern Illinois. Transactions — Ilinois State Academy of Science. 61: 314.

SMALL, J. 1917-19. The origin and development of the Compositae. New Phytologist. 16: 157-177; 198-221; 253-276. 1917. 17: 13-40; 69-94; 114-142; 200-230. 1918. 18: 1-35; 65-89; 129-176; 201-234. 1919.

SMALL, J. K. 1903. Flora of the southeastern United States. New York: published by the author. 1370 pp.

————. 1905. Additions to the flora of subtropical Florida. Bull. New York Bot. Gard. 3: 439.

————. 1909. Additions to the flora of peninsular Florida. Bull. Torrey Bot. Club. 36: 163.

STANDLEY, P. E. 1938. Flora of Costa Rica. Contr. Field Museum Nat. Hist. 18: 1493-1494.

STROTHER, J. 1970. Typification of *Melanthera* Rohr (Compositae: Heliantheae). Taxon. 19: 336.

SWARTZ, O. 1791. Observationes Botanicae. Erlangae: Palm. 424 pp.

TORRES, A. 1969. Revision of the genus *Philactis* (Compositae). Brittonia. 21: 322.

TURNER, B., W. ELLISON, & R. KING. 1961. Chromosome numbers in Compositae IV. North American species with phyletic interpretations. Amer. Jour. Bot. 48: 216-233.

———————. & D. FLYR. 1966. Chromosome numbers in the Compositae X. North American species. Amer. Jour. Bot. **53**: 24-33.

WALTER, T. 1788. Flora Caroliniana. London: J. Fraser. 263 pp.

WILD, H. 1965. The African species of the genus *Melanthera*. Kirkia. **5**: 1-17.

YOUNG, F. 1953. The rim of the Everglades. Everglades Nat. Hist. **1**: 103-112.

DEPARTMENT OF BIOLOGY
MILLERSVILLE STATE COLLEGE
MILLERSVILLE, PA. 17551

SENECIO ANONYMUS WOOD, AN EARLIER NAME FOR SENECIO SMALLII BRITTON[1]

ROBERT R. KOWAL AND T. M. BARKLEY

Taxonomists regret the occasional necessity to change long established specific epithets. While we firmly believe that adherence to the code of nomenclature is a practical necessity, we offer the present paper with some trepidation.

Senecio anonymus Wood is a widespread and often weedy plant of the southeastern United States. It has been known in the past almost exclusively as *Senecio smallii* Britt.

When Alphonso Wood introduced the epithet *anonymus* into the literature in 1861 (Class-book, p. 464), he presented it without citing an author's name. As Wood cited authors for other species, one might conclude that he merely noted an unnamed species of *Senecio*. However, in his *American Botanist and Florist* (1870, p. 187), Wood cited the name as *Senecio anonymus* Wood, thereby indicating his intent to use *anonymus* as a specific epithet. Article 23, Note 1, of the current *International Code of Botanical Nomenclature* (Stafleu, 1972) provides for the rejection of words not intended as names, but here *anonymus* must be regarded as an intentional name. The later publication date for *S. anonymus* (with the author's citation) antedates *S. smallii* Britt. (1894).

The name *S. anonymus* Wood has been previously found and indexed, but on the basis of the description in Wood's Class-book, Greenman treated it as a synonym for *S. tomentosus* Michx. (1803) (Merrill, 1948). Wood's (1861) descriptions of *S. tomentosus* and *S. anonymus* are as follows:

4 S. tomentosus Mx. Clothed with soft, cotton-like,

---

[1]Contribution No. 1167, Division of Biology, Kansas Agr. Expt. Station, Manhattan. Support by National Science Foundation Grant GB 5449 is gratefully acknowledged.

nearly persistent tomentum; root lvs. oblong or oblanceolate or ovate, obtuse, tapering to a long, slender petiole, crenate, the upper sessile; hds. fastigiate, rays 12 to 15; ach. pubescent. — 4 Va. to Fla. and La. St. 1 to 2f high, often nearly leafless above. Corymb simple, subumbellate. Root lvs. with their petioles 6 to 9′ long, 1 to 3′ wide. Rays spreading 16″. Apr. — Jn. — The leaves are exceedingly variable. A variety (on Stone Mt., Ga.) is low, densely tomentous [sic], with the lvs. all radical.

5 S. anonymus. Plant clothed with a white, partly deciduous tomentum; root lvs. small, oblong, obtuse, crenate-serrate, some of them slightly lobed, tapering to a petiole, cauline lvs. long and narrow, remotely sinuate-pinnatifid, the segm. cut-dentate; hds. subumbellate, small, ach. pubescent. — 4 ? Montgomery, Ala. St. 16 to 24′ high. Root lvs. ½′ wide and with their petioles 2 to 3′ long. St. lvs. 6′ long, the upper 1′, almost bipinnatifid. Rays 8 to 10, spreading about 7″. May., Jn.

Except for the tomentum mentioned, *S. anonymus* is clearly described in the original description as having the narrow basal leaves, pinnatifid cauline leaves and small heads regularly associated with the entity long-called *S. smallii.*

Alfonso Wood's herbarium eventually came to the College of Pharmaceutical Sciences, Columbia University (Merrill, 1948) and from there most of it went to the New York Botanical Garden. A search of the latter institution's herbarium produced no specimen resembling or bearing the name *S. anonymus* Wood. However, Dr. Frank Pokorny of the College of Pharmaceutical Sciences kindly located for one of us (R.R.W.) what we take to be the holotype among specimens left in the teaching collection. The holotype will now be permanently deposited in the New York Botanical Garden. The holotype bears the following label data: "Ex herbario Alfonso Wood / Senecio anonymus / Montgomery, Ala. / Legit ipse." No other data accompany

Figure 1. Holotype of *Senecio anonymus* Wood

Table 1

Senecio tomentosus, S. anonymus (S. smallii),
and holotype of *S. anonymus* compared

Character	*S. tomentosus**	Holotype of *S. anonymus*	*S. anonymus* (*S. smallii*)*
1. Basal leaf — length (cm)	22. (17., 29.)	—	16. (8., 23.)
2. Basal leaf — blade length (cm)	8.4 (8.0, 11.7)	—	6.7 (3.6,11.1)
3. Basal leaf — width (cm)	3.4 (2.5, 4.3)	1.3**	1.9 (1.5, 2.4)
4. Basal leaf — tooth number	25. (17, 34)	—	32. (16, 60)
5. Basal leaf — basal angle (degrees)	90. (69., 131.)	—	58. (29., 89.)
6. Stalk height (dm)	5.7 (4.7, 7.0)	4.3, 5.3	4.8 (3.0, 5.6)
7. Stalk width (mm)	4.4 (2.9, 5.8)	3.5	4.4 (2.5, 5.7)
8. Number of cauline leaves	7.3 (4, 14)	7	6.7 (5, 8)
9. Cauline leaf — length (cm)	5.1 (2.6, 7.0)	2.5 – 15.2**	8.6 (6.8,10.8)
10. Cauline leaf — width (cm)	1.2 (0.6, 1.8)	—	1.7 (1.2, 2.4)

Table 1 (cont.)

11. Cauline leaf — number of teeth	16. (9, 27)	—	57. (45, 73)
12. Cauline leaf — number of lobes	2.2 (1, 4)	—	7.5 (4, 11)
13. Inflorescence — number of heads	22. (7, 34)	ca. 32, ca. 52	64. (24, 97)
14. Inflorescence — number of branches	12. (7, 15)	13, 13	17. (10, 25)
15. Flowering head — diameter (cm)	1.9 (1.5, 2.1)	1.5 or 1.3**	1.3 (1.0, 1.6)
16. Involucre — length (mm)	7.7 (6.3, 8.2)	5.7	5.5 (4.7, 6.0)
17. Involucre — width at base (mm)	5.3 (4.0, 6.8)	3.0	3.9 (3.2, 4.8)
18. Ray floret — number	11.8 (9, 14)	8–10 or 6–9**	9.5 (7, 12)
19. Ray floret — ligule length (mm)	7.3 (6.2, 8.8)	5.5	5.3 (4.1, 6.4)
20. Ray floret — ligule width (mm)	2.1 (1.8, 2.4)	2.3	2.0 (1.6, 2.4)
Discriminant score	–3.3 (–4.7,–2.1)	2.4	3.3 (1.7, 4.8)

*Mean and range (in parentheses) based on 6 plants. Detailed definitions of characters are given in Kowal (1968).

**From descriptions (Wood, 1861 and 1870).

the specimen, which consists of but two flowering stalks and no basal rosettes (fig. 1).

The holotype appears to be a rather unexceptional specimen of the species. The tomentum mentioned in the original description is presumably what led Greenman to conclude that *S. anonymus* was a synonym for *S. tomentosus*, but the holotype is glabrescent except for a persistent tomentum in leaf and branch axils. This is a common feature in the species now called *S. anonymus*. A particularly noteworthy point is that *S. tomentosus* is not known to occur in the type locality (i.e., the vicinity of Montgomery, Alabama) where individuals identified as *S. smallii* recently have been seen (Joab L. Thomas, John D. Freeman, and Wilbur H. Duncan, *in lit.*).

Because many aureoid senecios appear to introgress freely with each other (Barkley, 1962; Kowal, 1968), there is always room for some doubt as to the biological nature of any specimen. Indeed, Chapman and Jones (1971) report limited natural hybridization between *S. tomentosus* and *S. anonymus* (as *S. smallii*) and, on the basis of artificial crosses, discuss the potential for introgression between them. In order to strengthen our argument, the holotype of *S. anonymus* was compared with materials of *S. tomentosus* and *S. anonymus* that were collected on May 11 and 18, 1969, along a roadside 4.1 miles east of Castalia, Nash Co., N. C. (Table 1; vouchers: Kowal, *s. n.*, at WIS). Here the two species grew together with limited but evident putative hybridization.

Discriminant analysis was used to confirm our interpretation of the holotype. This multivariate statistical technique can be used to objectively identify unknown individuals as belonging to one of two taxa or as being intermediate (Fisher, 1936; Morrison, 1967). Given means, variances, and convariances for a set of characters from each of the two taxa, discriminant analysis determines the weights for the weighted average (or coefficients for the linear combination) of the original characters that most efficiently separates the two taxa. It results in a

discriminant function, $Y = a_1X_1 + a_2X_2 + \ldots + a_pX_p - c$, where the Xi's (i = 1, . . ., p) are measurements on p characters on an individual, the ai's (i = 1, . . ., p) are the weights (or coefficients), and c is an arbitrary constant. Entering actual measurements (X_1, X_2, . . ., Xp) from an individual into the function gives that individual's discriminant score, Y. Comparing the discriminant score of an unknown individual with corresponding scores of individuals known to belong to the two taxa enables one to classify the unknown as one of the taxa or as an intermediate. In the present analysis logarithms of nine characters that could be measured on the type or derived from Wood's description were used to construct the discriminant function separating the North Carolinian local populations of *S. tomentosus* and *S. anonymus.* The coefficients and arbitrary constant of the discriminant function were calculated such that the pooled intraspecific variance of scores equalled one and such that the mean score for the two species were equal in absolute size but opposite in sign. Table 2 lists characters, coefficients, and coefficients standardized to facilitate evaluating the importance of characters to the discriminant function (as the original coefficients are dependent on arbitrary units of measurement). The holotype's score (2.4) is more than five standard deviations from the mean score of *S. tomentosus* (–3.3) but within one standard deviation of the mean score for *S. anonymus* (3.3). Thus, discriminant analysis substantiates treating the holotype of *S. anonymus* as a perfectly good member of the species heretofore called *S. smallii* Britt.

The synonomy for *Senecio anonymus* now becomes:

Senecio anonymus Wood, Class-book of Botany (ed. 1861). p. 464. 1861. Type coll.: *Wood, s.n.,* Montgomery, Ala. (NY).

Senecio smallii Britton, Mem. Torr. Bot. Club 4: 132. 1894. *Senecio aureus* var. *angustifolius* Britt. Mem. Torr. Bot. Club 2: 39. 1890. Type coll.: *Brown et al.*, "The Pass." Peaks of Otter, Va. (NY, PH).

Table 2

Coefficients of discriminant function separating *Senecio tomentosus* from *S. anonymus* using characters measurable on the holotype of *S. anonymus* Wood.

Character	Coefficients	Standardized coefficients*
1. Stalk height	6.0	.67
2. Number of cauline leaves	0.2	.04
3. Inflorescence — no. of heads	–1.5	–.55
4. Inflorescence — no. of branches	2.4	.54
5. Involucre — length	17.7	1.00
6. Involucre — width at base	–4.5	–.41
7. Ray floret — number	3.0	.37
8. Ray floret — ligule length	–1.0	–.11
9. Ray floret — ligule width	0.2	.03
Constant	43.2	29.00

*Standardized coefficients are those that would be used on data standardized such that the pooled intraspecific variance of each character equals one. The coefficient that is largest in absolute value is arbitrarily set equal to one.

Senecio earlei Small, Bull. Torr. Bot. Club **25**: 147. 1898. Type coll.: *Earle & Underwood,* Auburn, Lee Co., Ala. (NY).

Senecio smallii f. *tristis* Fernald, Rhodora **47**: 302. 1945. Type coll.: *Fernald* 14,859, Ram-Hole Swamp, Seward Forest, Near Triplett, Brunswick Co., Va. (GH).

LITERATURE CITED

BARKLEY, T. M. 1962. A revision of *Senecio aureus* Linn. and allied species. Trans. Kan. Acad. Sci. **65**: 318-408.

FISHER, R. A. 1936. The use of multiple measurements in taxonomic problems. Ann. of Eugenics **7**: 179-188.

KOWAL, R. R. 1968. *Senecio aureus* and allied species on the Gaspé Peninsula of Quebec. Ph.D. thesis, Cornell University, Ithaca, N. Y. 331 p.

MERRILL, E. D. 1948. Unlisted new names in Alphonso Wood's botanical publications. Rhodora **50**: 101-130.

MORRISON, D. F. 1967. Multivariate statistical methods. McGraw-Hill, N. Y. 338 p.

STAFLEU, F. (ed.) 1972. International code of botanical nomenclature. Regnum Vegetabile **88**: 1-426.

WOOD, A. 1861. Class-book of botany. Barnes and Burr, N. Y. 832 p.

————. 1870. The American botanist and florist. A. S. Barnes and Co., N. Y. and Chicago. 172 + 392 p.

DEPARTMENT OF BOTANY
UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN 53706

HERBARIUM, DIVISION OF BIOLOGY
KANSAS STATE UNIVERSITY
MANHATTAN, KANSAS 66502

A NOTE ON THE KARYOLOGY OF HAPLOPAPPUS SPINULOSUS (PURSCH) DC. SSP. TYPICUS HALL

L. S. GILL AND C. C. CHINNAPPA

Karyotypic studies and chromosome behaviour at meiosis are important to understand the genetic systems. Though some species of the genus *Haploppus* have been studied in this manner, no such information is available for *Haplopappus spinulosus* spp. *typicus* Hall. This is a small perennial Composite which ranges from Alberta to Minnesota and southwards to Texas and as far as Mexico. Several chromosome counts for this species have been recorded (Jackson 1957, 1962; Li and Jackson 1961; Dejong and Longpre 1963; Solbrig et al 1969). All of them, however, are from the southern range of its distribution.

The purpose of this note is to report the karyology of this species from the northernmost part of its distribution.

Seeds were collected from Brooks, Alberta in May 1971. Plants were raised in the greenhouse at the University of Waterloo. Meiotic and mitotic preparations were made following Gill (1971 a, b). Voucher (*L. S. Gill* 353) specimens are preserved in the University of Waterloo herbarium.

One hundred well spread metaphase cells from each of two plants were analyzed. Root tip cells of both plants have 8 chromosomes. One plant has 0-2 B– chromosomes (Figures 5, 6, 7). A haploid chromosome set is shown diagramatically in Figure 8. The smallest pair of chromosomes has almost median centromeres. Two pairs have submedian centromeres and the longest pair have subterminal centromeres. The smallest pair with the near median centromere is designated as 'A', and the rest as B, C, D respectively with the size increase. The length of Chromosome A is 8.2 microns and D is 13.1 microns. The arm length ratio are A– 0.87, B– 0.54, C– 0.80, and D– 0.15. Chromosome C has a distinct secondary constriction on its short arm. Table 1 presents a few more details.

The relative length and the centromere index are determined following Anderson (1970). The relative length reflects the amount of size homogeniety in each chromosome complement and centromere index shows the degree of terminalization of the centromere.

Table 1

Chromosome morphology of *H. spinulosus* spp. *typica.*

Plant	Absolute chromosome length in microns. longest	average	Relative length	Centromere index
1	13.2	10.3	0.61	1.63
2	13.1	10.1	0.68	1.65

One hundred meiotic cells in each plant were examined and all had a consistent haploid chromosome number of 4. with no B– chromosomes. The pair of A form a regular ring bivalent, pair of D as a rod bivalent. The other two submedian pairs are seen to form as two rings, but less frequently (Figures 1-4).

Li and Jackson (1961) mention that in *H. spinulosus* spp. *cotula* the smallest two regular chromosomes have an almost median centromere and are about 8.4 microns in length. There are no details mentioned about the other sets. They report the occurrence of differences in B–chromosome number in the cells of roots and flowers. B–chromosome number was not only different between root and shoot, but also existed from cell to cell within the same flower. The elimination of supernumerary chromosomes was not complete in the root as one plant was found to have $2n = 8 + 1$.

In view of the above, it is interesting to note the elimination of supernumerary chromosome in some of the plants of the subspecies *typicus* in its northern part of distribution. Earlier records of chromosome counts for ssp. *typicus* are $n = 4$ (Jackson, 1957), but different counts such as $2n = 8 + 2$, $8 + 3$, $8 + 4$, were reported in ssp. *cotula*

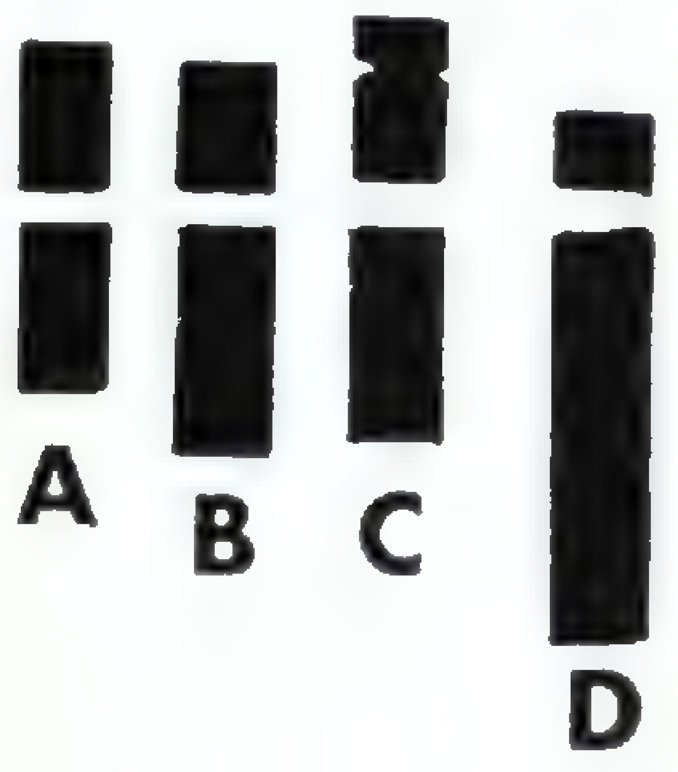


Fig.8

Figure 8. Idiogram of haploid chromosome set for *Haplopappus spinulosus* ssp. *typicus*. × 4000.

Figure 1. Two ring and two rod bivalents at diakinesis. × 2500.
Figure 2. Three ring and one rod bivalents in diakinesis. × 2500.
Figure 3. Three ring and one rod bivalents in diplotene. × 2500.
Figure 4. Late disjunction of one ring bivalent at anaphase one. × 2500.
Figure 5. Mitotic metaphase 2n = 8 + 2B chromosomes. × 2500.
Figure 6. Mitotic metaphase with 2n = 8 + 1B chromosome. × 2500.
Figure 7. Four mitotic cells with 8 chromosomes in each cell. × 1000.

(Li and Jackson, 1963). More recently Solbrig *et al.* (1969) reported n = 8 for ssp. *spinulosus*, which represents a new ploidy level for this species.

Chromosomal diversity, number and karyology, is evident within the species. A comprehensive study of the species and related ones from their entire range of distribution in North America is being undertaken to understand the evolutionary divergence in this interesting group of species.

LITERATURE CITED

ANDERSON, L. C. 1970. The Karyotype of *Chrysothamnus parryi* ssp. *parryi* and its implications. Trans. Kansas Acad. Sciences 72(3): 399-401.

DARLINGTON, C. D. 1963. Chromosome botany and the origin of cultivated plants. George Allen and Unwin Ltd. London. p. 231.

DEJONG, D. C., and E. K. LONGPRE. 1963. Chromosome studies in Mexican Compositae. Rhodora 65(763): 225-240.

GILL, L. S. 1971a. Cytology of West-Himalayan Labiatae: Tribe Satureineae. Caryologia 24(2): 203-207.

————. 1971b. Chromosome number of *Lysimachia ciliata* L. Rhodora 73(796): 556-557.

JACKSON, R. C. 1957. Documented Chromosome numbers of plants. Madrono 14: 111.

————. 1962. Interspecific hybridization in *Haplopappus* and its bearing on chromosome evolution in the Blepharodon Section. Am. J. Bot. 49(2): 119-132.

LI, N., and R. C. JACKSON. 1961. Cytology of supernumerary chromosomes in *Haplopappus spinulosus* ssp. *cotula* Am. J. Bot. 48(5): 419-426.

SOLBRIG, O. T., L. C. ANDERSON, D. W. KYHOS and P. H. RAVEN 1969. Chromosome numbers in Compositae VII: Asterae III Am. J. Bot. 56(3): 348-353.

DEPARTMENT OF BIOLOGY,
UNIVERSITY OF WATERLOO,
WATERLOO, ONTARIO

FLORAL STRUCTURE, HYBRIDIZATION AND EVOLUTIONARY RELATIONSHIP OF TWO SPECIES OF MIMULUS[1]

Y. T. KIANG

Floral characters of angiosperms have long been recognized as a useful guide in plant systematics. The diverse floral structures represent results of long periods of natural selection and often reflect a close relationship with breeding systems of plant species (Stebbins, 1970). Furthermore, they also play an important role in reducing interspecific crossing (Grant & Grant, 1965). Therefore, studies of floral characters in relation to breeding systems and ecological adaptation of plant species would contribute toward the understanding of processes of plant speciation.

Mimulus guttatus D. C. (Yellow monkey flower) and *M. nasutus* Green (Fig. 1) are two closely related species abundantly occurring in moist areas in California (Grant, 1924). The flowers of both species have yellow corollas with variable numbers and sizes of red blotches (Abrams, 1951). *Mimulus guttatus* is a perennial, self-compatible, but normally outcrossing species (Kiang, 1972), while *M. nasutus* is an annual and predominantly autogamous species. Since both species have similar geographical distribution, yet adopt distinctly different growth and breeding habits, they are desirable for the study of phylogenetic relationship by examining floral morphologies, hybridization and phenology in relation to their ecological adaptation. This paper reports the floral structure, breeding systems, hybridization and the possible evolutionary relationship of the two species. The studies indicate that the two species are phylogenetically closely related and *M. nasutus* is probably a daughter species of *M. guttatus.*

---

[1]Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 622.

M. guttatus

MATERIALS AND EXPERIMENTAL PROCEDURE

Populations of *Mimulus guttatus* and *M. nasutus* were established in the greenhouse from seeds collected from 10 randomly chosen plants from a single population of each species. The *M. guttatus* population was growing in granitic sandy soil along shallow channels of a creek about 800 m west of the entrance of Eureka State Park, California (120.70°W., 39.37°N.; elevation about 1820 m), while the *M. nasutus* population was in a roadside ditch watered by a small seep in the road cut of State Highway 70, Feather River Canyon near Rock Creek, California (121.28°W., 39.98°N.; elevation about 610 m).

Crosses between the two species were made on twenty plants of each species. In order to avoid contamination caused by the precocious dehiscence of anthers of *Mimulus nasutus,* emasculation had to be performed on the flower buds two or three days before they opened.

Since flowers of both species exhibit some degree of intraplant variation, only the third or the fourth node flowers on main stems were used for measuring the size of floral parts as well as estimating pollen viability by staining pollen with lactophenol aniline blue. The number of seeds from the mature capsules was counted, and the seed viability tested by germination. Total fertility and productivity of the two species and the hybrids were assessed. Chromosome counts were made from pollen mother cells following the techniques used by Mia *et al.* (1964). Both species were found to be diploid with $n = 14$.

RESULTS AND DISCUSSION

1. Floral characteristics and breeding system.

Viable seeds were harvested from all capsules on which interspecific pollination was attempted. *Mimulus guttatus*

Fig. 1. *Mimulus guttatus* (left) and *M. nasutus* (right) grown in the same pot (4") for about 8 weeks in the greenhouse. Many capsules can be seen on *M. nasutus,* while *M. guttatus* is just coming into bloom.

TABLE 1. The length of the floral organs and the ratio of stamen to pistil (in mm).

		Calyx	Corolla	Ovary	Style	Pistil	Stamen[1]	Stamen/ Pistil
M. nasutus	Mean	11.4	10.5	3.2	4.0	7.2	7.2	1.09
N = 74	CV	17.7	23.9	15.6	20.8	14.8	13.1	5.4
M. guttatus	Mean	9.4	26.5	4.6	12.1	16.8	12.9	.76
N = 45	CV	16.1	11.4	12.5	6.0	5.8	9.7	8.3
F_1	Mean	11.0	26.0	4.5	11.4	16.0	14.0	.86
N = 62	CV	13.1	11.1	11.7	7.6	6.6	7.5	6.2
F_2	Mean	11.1	21.0	3.9	9.6	13.5	11.4	.85
N = 58	CV	12.8	19.7	16.8	12.5	12.0	10.9	9.5
$F_1 \times$ *M. nasutus*	Mean	12.3	17.9	3.5	7.8	11.3	10.0	.90
N = 21	CV	8.2	28.7	16.8	25.2	19.7	14.5	10.5
$F_1 \times$ *M. guttatus*	Mean	10.6	23.6	4.2	10.5	14.8	12.0	.81
	CV	19.4	11.7	16.4	12.1	10.8	13.0	9.4

[1]Only long pair of stamen was measured.

N — Number of observation.

CV — Coefficient of variation (standard deviation erpressed as a percentage of the mean).

has smaller calyces and larger corollas than *M. nasutus* (Table 1). Floral parts of *M. guttatus* are relatively stable with respect to size. The stability of the floral characteristics is essential for the insect-pollinated plant species in achieving successful seed production. Any drastic change in floral parts may result in failure of pollination by pollinators. Contrary to the rather stable flower size of *M. guttatus, M. nasutus* exhibits morphological plasticity of the flower, particularly corolla size. Flowers are progressively reduced in size on a plant, and after ten nodes or so on the main stem, flowers often become so small as to be inconspicuous. Since *M. nasutus* is predominantly self-pollinated, there is no necessity to attract insect visitors by having large, showy flowers.

Both species have two pairs of stamens, one short and one long, in each flower. The two pairs of stamens in *Mimulus nasutus* are more or less similar in length and the anthers are clustered around the stigma. The bilabiate stigma, small and insensitive, always remains open, even in the flower bud. Thus, the structural arrangement of floral parts of *M. nasutus* greatly facilitates successful self-pollination.

In contrast, the pistil in *Mimulus guttatus* is much longer than the stamens, which themselves differ in length. The different stamen lengths may aid the visiting insects to obtain pollen. The large and sensitive bilabiate stigma opens up only when it becomes receptive.

The floral morphologies of the F_1 hybrids are somewhat intermediate between those of the parent species. Although there is a slight difference in the length of stamens and pistils, in the pollinator-free greenhouse every capsule produced by the hybrid is fully loaded with seeds. Self-pollination is facilitated by the lower lip of the stigma curling all the way back toward the anthers. Except for its autogamy, the morphology of the F_1 hybrid flower is more like that of *Mimulus guttatus*. The frequency distributions of the sum of three ratios (calyx to corolla, ovary to style and stamen to pistil) for the parent species,

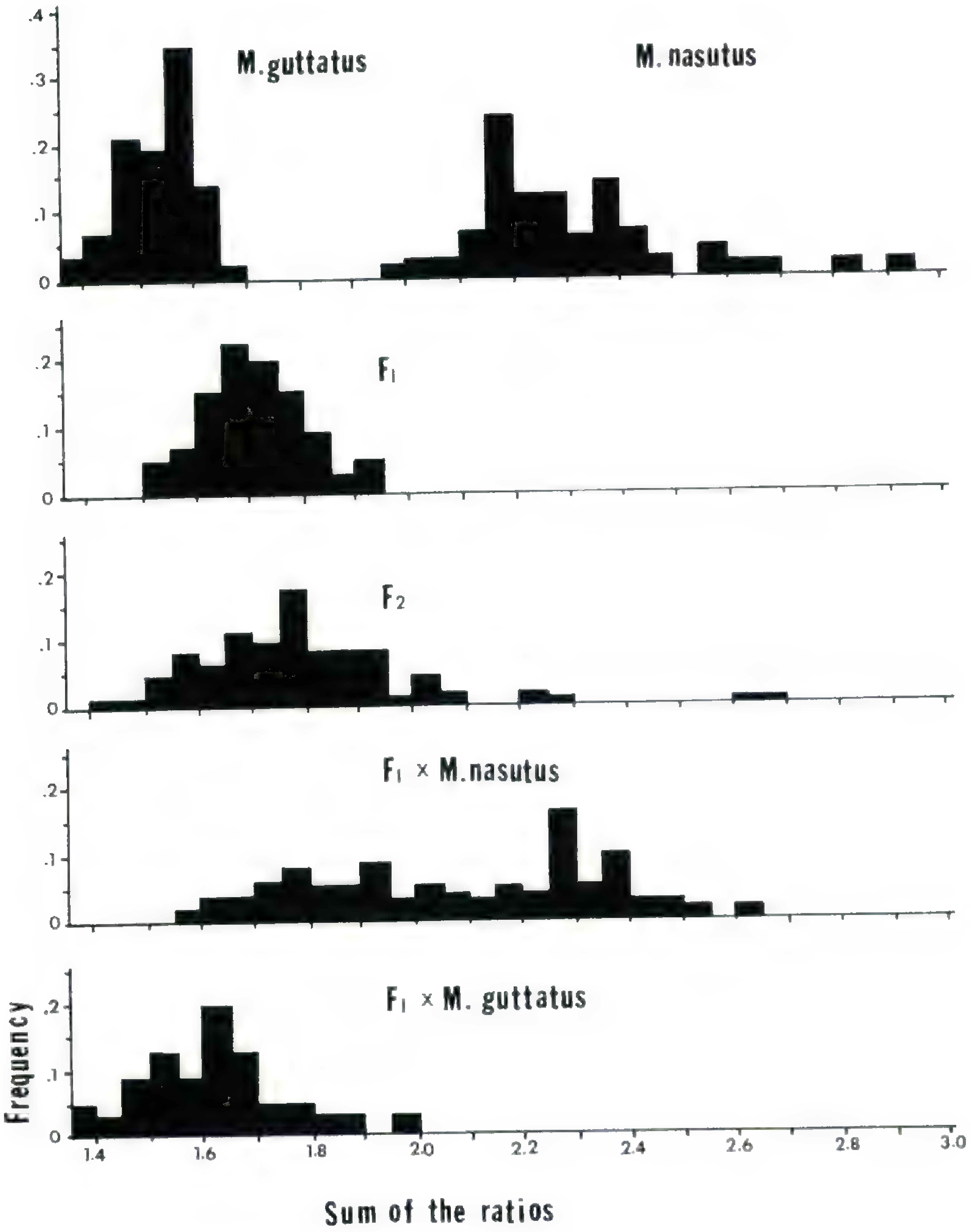


Fig. 2. Frequency distribution of the sum of ratios (calyx/corolla, ovary/style, stamen/pistil) of *M. guttatus*, *M. nasutus* and their hybrids.

the F_1, F_2 and backcross generations are plotted as histograms (Fig. 2). The distributional patterns suggest that the sum of the three ratios may be useful in studying hybridization and introgression in natural populations of *Mimulus*.

The time of anther dehiscence and occurrence of self-pollination in *Mimulus nasutus* may be a significant factor in seed setting and in reducing gene exchange between the two species. Twenty flowers each from one plant were emasculated by pulling off the corollas within 10 hours after the flowers were open. No seed was produced by the emasculated flowers of *M. guttatus*. In the case of *M. nasutus*, all emasculated flowers yielded on the average as many seeds as from non-emasculated ones. In the F_1 hybrid, 8 out of 20 emasculated flowers (or 40%) produced seed, and the average number of seed per capsule was only 49, much smaller than that produced by a non-emasculated flower.

When flower buds of the F_1 and *Mimulus nasutus* were carefully dissected to examine anthers, no pollen shedding was noticed in the F_1 hybrid, but in *M. nasutus*, the anthers had dehisced, and the stigmas were full of pollen grains. One day or two prior to the opening of the flower, the style of *M. nasutus* bends inward slightly, bringing the open stigma in contact with the dehiscent anthers to ensure self-pollination. Therefore, in *M. nasutus* pollination normally occurs before flowers open. Pseudocleistogamy has been used to describe this phenomenon (Vickery, 1964).

In annual plants, seed set in a season is one of the most crucial factors for the continuing survival of populations. Plants of *Mimulus nasutus* usually start to produce capsules when plants are still at the 2 true leaf stage. The first two or four precociously produced capsules are smaller than normal ones, and usually set seeds by cleistogamy. Several larger chasmogamous flowers very similar to those of *M. guttatus* will follow the first four flowers; then, as the blooming progresses, the flowers rapidly reduce in size.

2. Fertility and biomass

Pollen fertility.

On the average, 98% of *Mimulus nasutus* pollen and 93% of *M. guttatus* pollen were stained. The F_1 pollen (88% stained) was about 10% less fertile relative to that of *M. nasutus* and the difference is statistically significant.

Mimulus guttatus on the average produced more pollen grains per flower than *M. nasutus* (30368 ± 218 vs. 20958 ± 44). The amount of pollen produced by the F_1 hybrid (24006 ± 135) was approximately intermediate between the parental species. In *M. nasutus*, less than one-third of pollen grains remained in the anthers of newly open flowers (6775 ± 65), because pollen shedding occurs before flowers open. The precocious dehiscence of anthers in *M. nasutus* may reduce pollen flow within and between species. There is no evidence of nectar glands in *Mimulus* (Grant, 1924); thus, insects visiting the flowers are foraging for pollen. Generous pollen production would be advantageous for *M. guttatus* in achieving outcrossing.

Seed production and germination.

Mimulus guttatus produces on the average 401.5 ± 94 seeds per capsule, *M. nasutus* 256.4 ± 39 and the F_1 492. ± 96. The data indicate that the F_1 can potentially produce more seeds per capsule than the parental species.

In order to test viability, 200 seeds from each species, F_1 and the F_1 backcross were sown on moist filter paper. The germination percentages were *Mimulus guttatus*, 90.5%; *M. nasutus*, 84.0%; F_1 84.4% and F_1 backcross, 74.5%. There was no significant difference in seed viability between the parental species and the F_1 hybrid. However, the proportion of seed germination declined appreciably in the seed of the F_1 backcross.

Production of flowers, capsules and biomass.

To assess productivity, plants were harvested after growing in the greenhouse for three months. The average number of flowers, capsules, stolons, and the dry biomass

TABLE 2. Fertility and biomass production in *M. nasutus, M. guttatus*, F_1, F_2 and backcross progeny.[1]

					Dry Weight (g)				
		Days to Flower	Main Stem Length (mm)	# Fls. & Capsules	Leaves Stems	Stolons	Fl. & Capsule	Total	Fl. & Capsule/ Total
M. nasutus N = 20	Mean	42.6	52.4	231.4	1.73	0	1.00	2.73	.366
M. guttatus N = 20	Mean	56.4	62.0	86.0	3.6	.64	.20	4.43	.045
F_1 N = 25	Mean	49.0	55.2	178.5	2.29	.22	.67	3.18	.211
F_2 N = 20	Mean	49.5	51.7	150.2	2.49	.48	.34	3.34	.102
F_1 × *M. nasutus* N = 21	Mean	48.1	47.7	181.6	1.58	.10	.69	2.37	.291
F_1 × *M. guttatus* N = 29	Mean	51.1	55.7	149.0	3.56	.31	.32	4.18	.077

[1]Plants grown in 4″ pots in the greenhouse from December 23, 1971 to March 24, 1972.

are presented in Table 2. When the productivity of the two species was compared, the differences between them were found to be statistically significant. *Mimulus nasutus* started to bloom early and terminated early. It usually branches from the base of the stem, and soon all branches become ascending with flowers.

When the reproductive effort of the plants was examined, *Mimulus nasutus* invested more energy in seed production than *M. guttatus* and the F_1. The flowers and capsules consisted of 36.6% of the total biomass in *M. nasutus*, but only 4.5% in *M. guttatus*. *Mimulus nasutus* is an annual, and seed production is crucial for continuation of the annual species. On the other hand, vegetative propagation is more important to *M. guttatus*, a perennial, for maintaining its population. In fact, *M. guttatus* showed more vegetative growth than *M. nasutus*, and produced a considerable amount of stolons, or 14.5% of the total biomass (Table 2).

In order to determine whether hybridization between the two species is generally possible, three additional populations of the two species and plants from Feather River Canyon and Eureka State Park were intercrossed. They were all interfertile.

All the experimental data indicate that barriers do not exist to prevent gene exchange either between *Mimulus guttatus* and *M. nasutus*, or between the parental species and the F_1 hybrids. The F_2 plants under greenhouse conditions were quite vigorous and showed no sign of sterility or breakdown.

3. Relationship of *Mimulus guttatus* and *M. nasutus*.

It has been well established that self-fertilized plant species are always derived from outbreeding ancestors, and annuals are most likely derived from perennials (Stebbins, 1957; Baker, 1959). The evidence from floral structure, breeding systems and fertility of hybrids strongly supports the view that *Mimulus guttatus* and *M. nasutus* are genetically closely related species and the latter is newly

derived from the main species, *M. guttatus* (Vickery, 1964). It has been demonstrated with many closely related pairs of species in *Clarkia* that one member of the pair is derived from the other (Vasek, 1958; Lewis and Raven, 1958). Lewis (1962) has suggested that the daughter species in *Clarkia* are derived from marginal populations which are often subject to catastrophic selection leading to a rapid genetic reorganization and formation of the daughter species. The evolutionary relationship of *Mimulus guttatus* and *M. nasutus* may represent such a rapid evolution as a consequence of the joint action of mutation, selection and genetic drift.

Changes of breeding systems from outcrossing to self-pollination under the unusual ecological environments have been reported. *Gilia achilleaefolia* subsp. *multicaulis*, predominantly autogamous, is derived from normally outcrossing, but self-compatible *G. a.* subsp. *achilleaefolia* (Grant and Grant, 1965). A similar change has been observed in *Mirabilis longiflora*, a self-compatible species in a genus where self-incompatibility is known, which in the absence of successful insect visitation sets seeds by self-pollination (Baker, 1961a). A change of breeding system from outbreeding to inbreeding in plant species could trigger the rapid formation of a new species (Baker, 1961b). Although a direct observation of the formation of *Mimulus nasutus* from *M. guttatus* is not possible, one is tempted to reconstruct a hypothetical evolutionary process of *M. nasutus* based on the evidence gathered in this study, and on the available examples cited above.

Mimulus guttatus is a riparian species which maintains its populations largely by long life span and by growing profuse stolons as propagules in nature (Kiang and Libby, 1972). However, only in a moisture-stable environment can it grow as a perennial and reproduce vegetatively. Therefore, if environmental conditions of a peripherally isolated population happen to become dry and unstable, the population may no longer be able to maintain itself by vegetative propagation. Thus, seed production becomes a

decisive factor for continuation of the population under arid conditions, which would stimulate a rapid evolution (Axelrod, 1967). Moreover, it is probable that insects may fail to visit the small number of flowers produced by one or a few plants surviving from the catastrophic selection (Lewis, 1962). Therefore, under conditions of unstable moisture availability, only individuals with successful self-pollination can produce seeds, and autogamy has obvious immediate high selective value (Stebbins, 1950; Grant & Grant, 1965).

When the environment becomes favorable, a new population may be established from the seeds produced by self-pollination. The newly founded colony with self-pollination will lead to genetic change, and those new, well adapted individuals would become the progenitors of the daughter species. Thus, the daughter species, *Mimulus nasutus* may have been derived from one or several plants which obtained a new adaptive mode under the favorable conditions.

The greenhouse and field observations strongly support the hypothesis that *Mimulus nasutus* is derived from *M. guttatus* under moisture unstable conditions. In the greenhouse 30 seeds of each species were sown in each of the 5 moisture saturated 8″ pots. One week after the seeds were sown, irrigation was completely discontinued. About 86% of *Mimulus guttatus* and 83% *M. nasutus* germinated. No *M. guttatus* survived to produce flowers, but 8 *M. nasutus* per pot survived to produce on the average 3.6 mature capsules. In nature, *Mimulus nasutus* occurs more commonly in the southern parts of the Sierra, where moisture supply is less dependable. Under normal conditions, it reaches the peak of bloom in relatively short days, April and May when moisture is most abundant (J. L. Hamrick, personal communication). The phenology of *Mimulus nasutus*, larger cotyledons with a rapid seedling growth and precociously produced capsules by self-pollination, are clearly indicative of its adaptation to a moisture unstable environment.

CONCLUSION AND SUMMARY

The breeding systems, floral structure, and phenology of *Mimulus guttatus* and *M. nasutus* were compared. The former is an outcrossing perennial while the latter is a self-pollinated annual. *Mimulus guttatus* has large, showy corollas and long pistils with sensitive labiate stigmas, whereas *M. nasutus* has small corollas which are variable in size, and short pistils with anthers clustered around stigmas. The anthers of *Mimulus nasutus* dehisce precociously and, therefore, self-pollination occurs before flowers open. Greater variation with regard to several quantitative traits was observed in *M. guttatus* than in *M. nasutus*. *Mimulus nasutus* has a higher reproductive effort than *M. guttatus,* which exhibits more vegetative growth.

Fully fertile hybrids were obtained experimentally. The growth pattern and floral characters of the F_1 hybrids are intermediate between the parental species. The hybrids can set seed by self-fertilization and grow as perennials with stolons.

A comparison of fertility and productivity indicates that there is no complete postmating isolating mechanism between *M. guttatus* and *M. nasutus.* The evidence suggests that the two species are genetically closely related and *M. nasutus* may be a daughter species newly derived from *M. guttatus. Mimulus nasutus* may represent the product of quantum evolution (Grant, 1971) as a consequence of the joint action of mutation, selection and genetic drift.

ACKNOWLEDGMENTS

I gratefully acknowledge the generosity of Professors James L. Hamrick and Robert K. Vickery, Jr., in providing the seeds for this investigation. I wish to thank H. G. Baker, and J. L. Hamrick for reading the early draft of the manuscript, and their valuable suggestions. This investigation was partly supported by a UNH 1972 Faculty Summer Fellowship.

LITERATURE CITED

ABRAMS, LEROY. 1951. Illustrated flora of the Pacific states. Vol. III. Stanford Univ. Press. 866 p.

AXELROD, D. I. 1967. Drought, diastrophism, and quantum evolution. Evolution **21**: 201-209.

BAKER, H. G. 1959. Reproductive methods as factors in speciation in flowering plants. Cold Spring Harbor Symp. Quant. Biol. **24**: 177-191.

————. 1961a. The adaptation of flowering plants to nocturnal and crepuscular pollinators. Quart. Rev. Biol. **36**: 64-73.

————. 1961b. Rapid speciation in relation to changes in breeding systems of plants. (Pp. 881-885) *In* Recent advances in Botany. Toronto Univ. Press. Toronto.

GRANT, ADELE L. 1924. A monograph of the Genus *Mimulus*. Ann. Misso. Bot. Garden **11**: 99-389.

GRANT, V. 1971. Plant speciation. Columbia Univ. Press. New York. 435 p.

————, and K. A. GRANT. 1965. Flower pollination in the Phlox family. Columbia Univ. Press. New York.

KIANG, Y. T. 1972. Pollination study in a natural population of *Mimulus guttatus*. Evolution. **26**: 308-310.

————. and W. J. LIBBY. 1972. Maintenance of a lethal in a natural population of *Mimulus guttatus*. Amer. Nat. **106**: 351-367.

LEWIS, H. 1962. Catastrophic selection as a factor in speciation. Evolution **16**: 257-271.

————, and P. H. RAVEN. 1958. Rapid evolution in *Clarkia*. Evolution **12**: 319-336.

MIA, M. M., B. B. MUKHERJEE, and R. K. VICKERY, JR. 1964. Chromosome counts in the section simiolus of the Genus *Mimulus* (Scrophulariaceae). IV. New numbers in *M. guttatus*, *M. tigrinus*, and *M. glabratus*. Madrono **17**: 156-160.

STEBBINS, G. L., JR. 1950. Variation and evolution in plants. Columbia Univ. Press. New York. 643 p.

————. 1957. Self-fertilization and population variability in the higher plants. Amer. Nat. **91**: 337-354.

————. 1970. Adaptive radiation of reproductive characteristics in Angiosperms, I: Pollination mechanisms. *In* Annual Rev. of Ecol. and Systematics. Vol. **1**: 307-326.

VASEK, F. C. 1958. The relationship of *Clarkia exilis* to Clarkia unguiculata. Amer. Jour. Bot. **45**: 150-162.

VICKERY, R. K., JR. 1964. Barriers to gene exchange between members of the *Mimulus guttatus* complex (Scrophulariaceae). Evolution **18**: 52-69.

DEPARTMENT OF PLANT SCIENCE
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824

PALYNOLOGICAL EVIDENCE FOR THE LATE GLACIAL OCCURRENCE OF PRINGLEA AND LYALLIA ON KERGUELEN ISLANDS[1]

STEVEN B. YOUNG[2]

EILEEN K. SCHOFIELD[3]

Kerguelen Islands are an isolated subantarctic archipelago situated in the southern Indian Ocean (Fig. 1). The nearest continental land masses other than Antarctica are Africa and Australia, each some 4,000 km distant. The native vascular flora of Kerguelen includes only about 30 species (Lourteig and Cour, 1963; Aubert de la Rüe, 1964). The majority of the non-endemic species have their affinities with the Magellanic flora of southern South America. A lesser number of species also occur in New Zealand and southern Australia. A few of the species found on Kerguelen, such as *Cystopteris fragilis* (L.) Bernh., are nearly worldwide in their distribution.

Six species are endemic to Kerguelen or to Kerguelen and such nearby islands as Heard and Crozet. Both the quantity and the nature of the endemic species are unique in the subantarctic, and this region has been considered to be a distinct phytogeographic province (Good, 1964), although most other provinces support floras of over 100 times as many species.

The validity of the concept of the Kerguelen phytogeographic province depends upon the assumption that the flora has been isolated for a long period of time. However, much of the surface of Kerguelen is presently covered with ice, and there is some reason to believe that virtually all of the island may have been glaciated, eliminating all sig-

---

[1]Contribution No. XXX of the Institute of Polar Studies, The Ohio State University.

[2]Present address: Center for Northern Studies, Wolcott, Vermont 05680.

[3]Present address: New York Botanical Garden, Bronx, New York 10458.

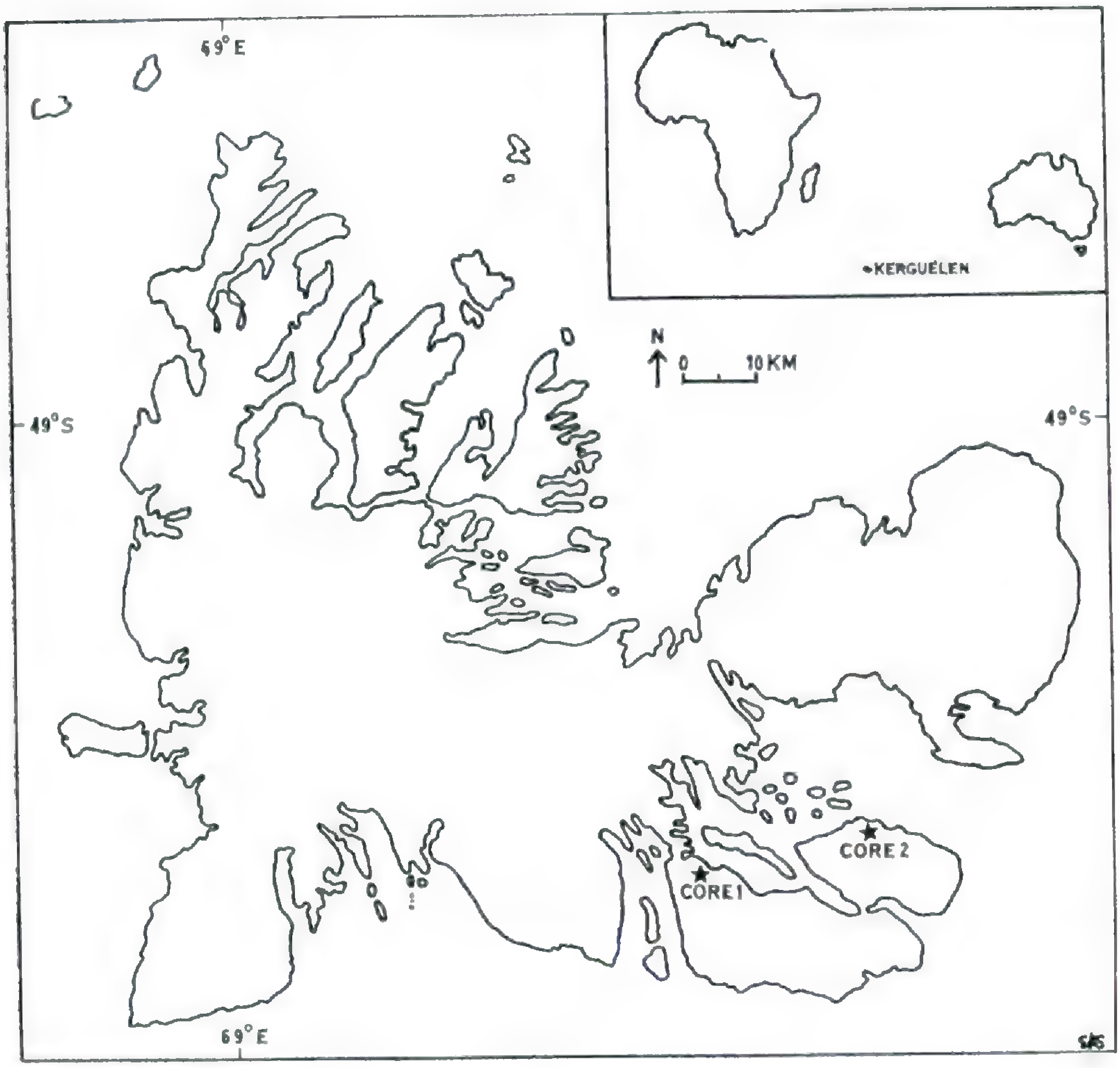


Fig. 1. Map of Kerguelen Archipelago with stars marking sites of cores. Inset shows position of Kerguelen in relation to Africa and Australia.

nificant vegetation during the Pleistocene. We now offer evidence that the most characteristic members of the Kerguelen endemic flora were present on the islands during the latter part of the last major glacial episode.

Four of the six species endemic to the Kerguelen region (*Poa Cookii* Hook, f., *P. kerguelensis* (Hook. f.) Steuder, *Colobanthus kerguelensis* Hook. f., and *Ranunculus Mosleyi* Hook. f.) belong to large genera which are well represented throughout most of the far south. Although all four species are reasonably distinct, there is no intrinsic reason to postulate a long period of isolation on Kerguelen for them.

The remaining two endemic species, *Lyallia kerguelensis* Hook, f. and *Pringlea antiscorbutica* R. Br. ex Hook. f., belong to monotypic genera which have no close relatives. In the subantarctic flora these two genera are unique with regard to their taxonomically isolated position, and they provide the main support for the contention that the Kerguelen region can properly be considered to be distinct phytogeographic province. It is known that Kerguelen supported a complex flora, including coniferous trees, during the mid-Miocene (Cookson, 1947; Nougier, 1970). If Kerguelen has never been completely denuded of its flora by ice advances, it is probable that *Lyallia* and *Pringlea* are the last living remnants of a Tertiary Kerguelenian flora.

Pringlea antiscorbutica, the well-known "Kerguelen cabbage", was used by seamen during the last century for the control of scurvy. It occurs on Kerguelen, Heard, Crozet, Marion, and Prince Edward Islands (Lourteig and Cour, 1963). *Pringlea* (Fig. 2) bears a superficial resemblance to the cultivated cabbage. The vegetative portion of the plant consists of a rosette of blue-green leaves which may lie nearly flat on the ground or may be borne atop a fleshy rootstock to 1 m tall and 10 cm in diameter. The inflorescence consists of one to several spikes which arise from the base of the rosette at its junction with the rootstock. The petals of the numerous flowers are reduced or absent.

Rabbits, which were introduced on Kerguelen in 1874 (Aubert de la Rüe, 1964) have apparently eliminated *Pringlea* from many of its former habitats, and it is now difficult to reconstruct the former natural distribution of the species. In areas not presently inhabited by rabbits, *Pringlea* is common to abundant in mesic situations near sea level, particulary where the soil has been enriched by sea-bird colonies. *Pringlea* will tolerate salt spray, and it is often found growing with *Cotula plumosa* Hook. f. in coastal situations. Plants of *Pringlea* are also found in high-elevation vegetation dominated by *Azorella selago*

Fig. 2. *Pringlea antiscorbutica* R. Br. ex Hook. f. showing basal rosette of leaves and fruiting stalks. Although this specimen was found at an elevation of about 600 m, the leaves show evidence of rabbit grazing.

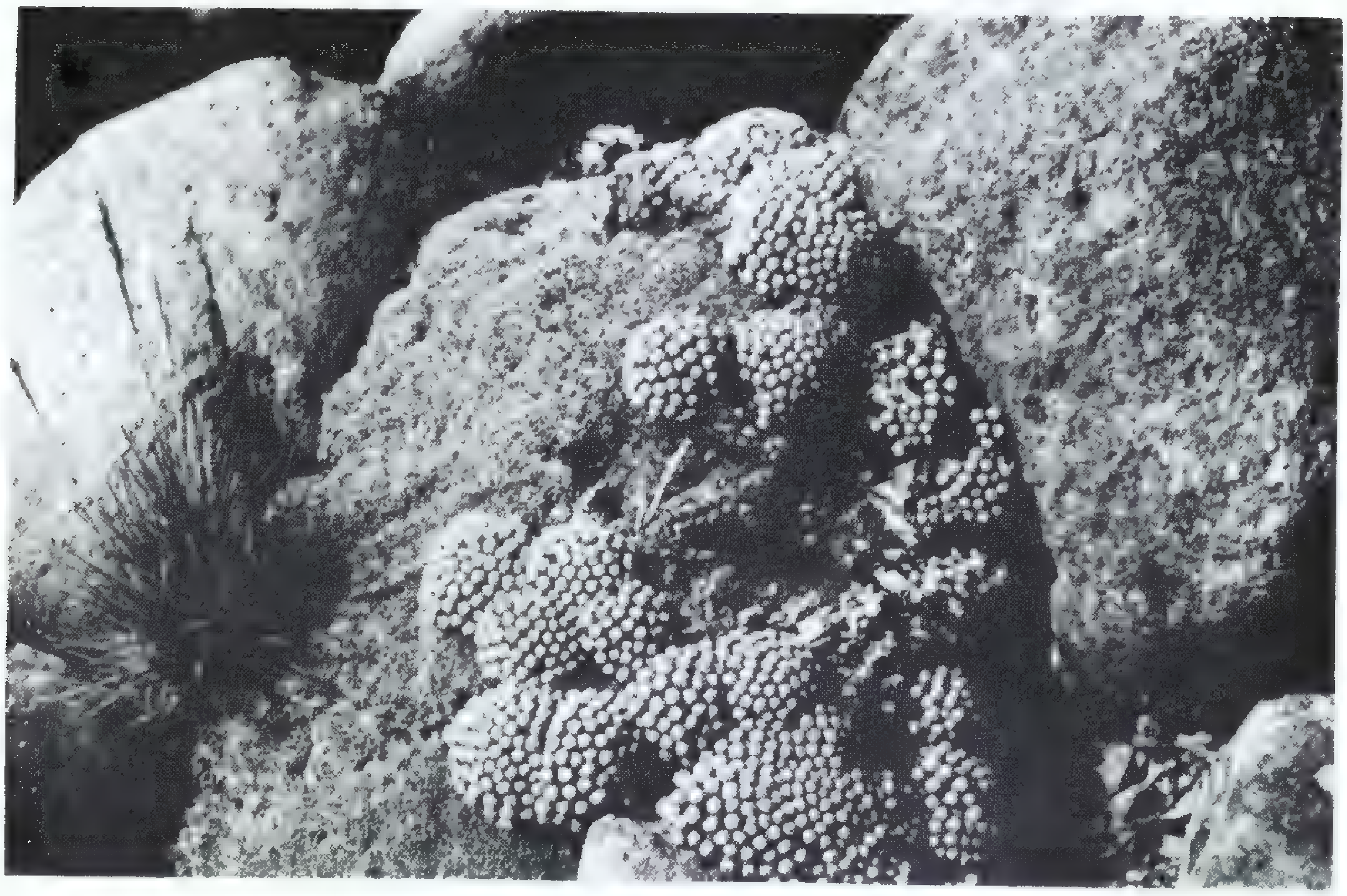


Fig. 3. *Lyallia kerguelensis* Hook. f.

Hook. f. where there is abundant moisture from seepage or meltwater. It is doubtful that *Pringlea* was ever a significant component of the vegetation of the upland wind deserts of Kerguelen. The species is never seen in boggy areas. It appears that *Pringlea* is tolerant of low temperatures and high winds, but that it requires a continuous supply of moisture and good drainage.

Lyallia kerguelensis occurs only on the Kerguelen archipelago. It is a dwarf cushion plant (Fig. 3) which is rather rare over most of the main island, although it is common on Long Island in the Gulf of Morbihan (H. A. Imshaug, personal communication). *Lyallia* grows mainly on stony barrens at low to moderate elevations.

Lyallia, with its small and highly reduced flowers, has been something of a puzzle to taxonomists since its discovery. First placed in the Caryophyllaceae by Hooker (1847), it was later transferred to the Portulacaeae (Kidder, 1876). More recently, *Lyallia* has been linked with the genus *Hectorella,* which is native to alpine areas in New Zealand, and both genera are considered to be in a

separate family, the Hectorellaceae (Philipson and Skipworth, 1961). The pollen of *Lyallia,* which is clearly neither portulacaceous or caryophyllaceous, supports the placement of the genus in another family (Cranwell, 1963).

PALYNOLOGICAL STUDIES

In February 1971, columns of peat and buried soils were collected from the sides of stream cuts in two locations on the south shore of the Gulf of Morbihan (Fig. 1). These cores have since been analyzed for pollen content and dated by radiocarbon techniques.

Core 1 is 308 cm long. A C-14 date at a depth of about 240 cm was 9230 ± 150 years B.P. (I-6661), while a date from a depth of about 250 cm was 8595 ± 125 years B.P. (I-6154). This small anomaly in the dates is most probably a result of contamination of the lower sample with recent material, but it could also be caused by the presence of reworked older sediments in the upper sample. If the 240-cm date is taken to be the most nearly correct, the lowermost strata of core 1 would probably have been deposited 12,000 to 12,500 years B.P. If the 250 cm date is accepted, the oldest strata would be 1,000 to 1,500 years younger. The strata below the bottom of core 1 contained large, rounded boulders embedded in blue clay-silt. These strata may be of glacial origin.

Core 2, which was 550 cm long, did not penetrate to any till-like strata. Buried organic soils were found below the bottom of the core, but seepage problems made sampling impossible. A sample from a depth of approximately 525 cm was dated at 11,010 ± 160 years B.P. (I-6284). If we consider the late glacial-postglacial boundary in the far southern hemisphere to be about 10,000 years B.P. (Heusser, 1966; Flint, 1971), both cores include late glacial sediments.

There can hardly be doubt that the glaciers of Kerguelen were more extensive during parts of the Pleistocene than they are now, but evidence for total glaciation of the islands

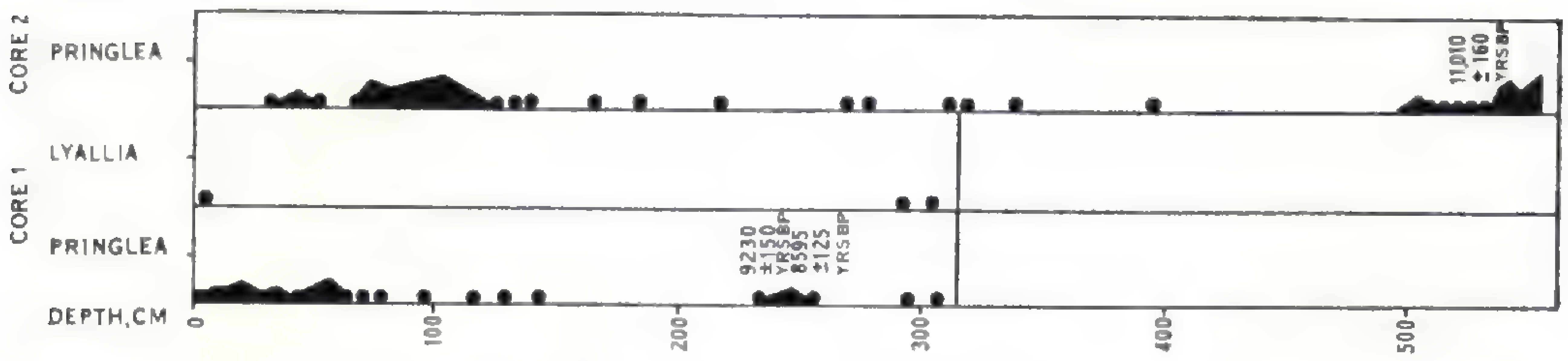


Fig. 4. Partial pollen diagram showing distribution of *Pringlea* and *Lyallia* pollen in cores 1 and 2. The percentages are based on a total count of 150 grains per sample. Each division at the top represents 10% and a dot represents 2% or less.

is lacking (Bellair, 1965). As the site of core 2 was ice-free well into glacial times, we suggest that it may not have been glaciated during the Pleistocene.

The pollen and spore content of the Kerguelen cores is presently being analyzed as a means of reconstructing the late Quaternary climatic history of the islands. Neither *Pringlea* nor *Lyallia* was found to be a major constituent of the pollen rain, but some pollen of both species was found in the cores (Fig. 4). *Pringlea* pollen was present in the lowermost samples of both cores. At the bottom of core 2, *Pringlea* pollen amounted to 6% of the total pollen counted, a percentage as high as was found in any other sample in either core. *Pringlea* was a constituent of the vegetation near the site of core 2 more than 11,000 years ago. If the relative lack of *Pringlea* pollen in some of the upper levels of the cores has any significance, it may indicate that *Pringlea* was replaced at low elevation by less cold tolerant species. The *Pringlea* pollen content of core 1 was similar to that of core 2 except that there was no peak at the lowest levels.

Lyallia pollen was much rarer than that of *Pringlea;* it was never found in core 2 and was found in only three samples from core 1. However, the presence of clearly identifiable *Lyallia* pollen at the bottom of core 1 shows that the species did grow on the island more than 10,000 years ago. *Lyallia* is neither an abundant plant nor does it flower heavily on Kerguelen at present; thus, its comparative rarity in the pollen record is not surprising.

In view of the evidence presented here, we may state with certainty that both *Pringlea* and *Lyallia* were present on Kerguelen during late-glacial times. The presence of pollen of these species in our oldest samples, coupled with the lack of evidence for complete glaciation of Kerguelen, suggests that these species did indeed "overwinter" the Pleistocene epoch on Kerguelen. It is not necessary to postulate an extra-insular refugium for these species, with subsequent migration to Kerguelen and extinction in the refugial area. *Pringlea* and *Lyallia* are probably true relicts of an otherwise extinct Tertiary Kerguelenian flora.

ACKNOWLEDGMENTS

This research was supported by National Science Foundation grant GV-26139. Logistic support for field work on Kerguelen was supplied by TAAF (Terres Australes et Antarctiques Françaises). We thank E. D. Rudolph and J. F. Splettstoesser for commenting on the manuscript and P. A. Colinvaux for use of his laboratory facilities.

LITERATURE CITED

AUBERT, DE LA RÜE, E. 1964. Observations sur les caractères et la répartition de la végétation des Iles Kerguelen. Com. Nat. Franç. Rech. Antarct. No. 10, Biologie **1**: 1-60.

BELLAIR, P. 1965. Un exemple de glaciation aberrante: les Iles Kerguelen. Com. Nat. Franç. Rech. Antarct., No. **11**: 1-27.

COOKSON, I. C. 1947. Plant microfossils from the lignites of Kerguelen Archipelago. Brit. Aust. N. Z. Antarct. Res. Exped. 1924-31. II (Geology): 127-142.

CRANWELL, L. M. 1963. The Hectorellaceae: pollen type and taxonomic speculation. Grana Palynol. **4**: 195-202.

FLINT, R. F. 1971. Glacial and Quaternary Geology. John Wiley, N. Y. 892 p.

GOOD, R. 1964. The Geography of Flowering Plants. 3rd ed. J. Wiley, N. Y. 518 p.

HEUSSER, C. J. 1966. Polar hemisphere correlations of palynological evidence from Chile and the Pacific northwest of America. In: Sawyer, J. S. (ed.) World Climate from 8000 to 0 B.C. Proc. Roy. Meteorol. Soc. Int. Symp. 124-141.

HOOKER, J. D. 1847. Botany of the Antarctic Voyage of H. M. Discovery Ships Erebus and Terror . . . . II: 548. Reeve Bros., London.

KIDDER, J. H. 1876. Contribution to the natural history of Kerguelen Island, made in connection with the United States Transit-of-Venus Expedition, 1874-75. Bull. U.S. Nat. Mus. **3**: 1-122.

LOURTEIG, A. and P. COUR. 1963. Essai sur la distribution géographique des plantes vasculaires de l'archipel de Kerguélen. Com. Nat. Franç. Rech. Antarct. No. 3: 65-78.

NOUGIER, J. 1970. Contribution a l'étude géologique et géomorphologique des Iles de Kerguelen. Com. Nat. Franç. Rech. Antarct. **27**: 1-440.

PHILIPSON, W. R. and J. B. SKIPWORTH. 1961. Hectorellaceae: a new family of dicotyledons. Trans. Roy. Soc. N.Z., Botany **1**(4): 32.

INSTITUTE OF POLAR STUDIES
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

PHYTOGEOGRAPHY OF THE CARICES OF VIRGINIA

A. M. HARVILL, JR.

The carices growing in Virginia include *Carex*, a large and cosmopolitan genus with a preponderance of species in temperate regions of the Northern Hemisphere, and the monotypic genus, *Cymophyllus*, endemic to the Southern Appalachians. *Carex* is by far the largest genus of vascular plants in Virginia, with 121 species recognized in this study. Each species of the carices is, as a rule, well-defined, has its own distributional pattern, and has particular ecological requirements. There are woodland, meadow, bog, marsh, swamp, rock, calcicolous, and arenaceous species. The geographic affinities of the native Virginia carices are circumboreal, Asiatic-American, and strictly American. Within the state of Virginia these species show most of the patterns occurring in other vascular plants.

During the course of this study, counties' records from voucher specimens were plotted on outline maps of Virginia, and these data will be published at a later date. Collections were studied at the College of Wiliam and Mary, Gray Herbarium, Lynchburg College, National Arboretum, New York Botanical Garden, University of North Carolina, Old Dominion University, Philadelphia Academy of Science, Smithsonian Institution, West Virginia University, Virginia Commonwealth University, and Virginia Polytechnic Institute. The writer is indebted to the respective curators for their generosity.

In general, I have taken a rather wide view of some species, for, until some of the closely related taxa are better understood, Joseph Hooker's rationale in his work on arctic plant distribution (1862) still seems most useful for phytogeographic purposes: "My main object is to show affinities of the polar plants, and I can best do this by keeping the specific idea comprehensive. It is always easier to indicate differences than to detect resemblances . . ."

This paper would have been much less complete but for the outstanding collections of Dr. Henry K. Svenson, mostly from our coastal plain; and those of Mr. Charles E. Stevens from many areas of the state, especially the higher levels on mountains of western Virginia. Four of Stevens' collections were new records for the state: *Carex brevior, C. pallescens, C. polymorpha,* and *C. rostrata.* Also, Dr. John Wurdack gave many helpful suggestions, Dr. Sydney McDaniel pointed out the Fernald-Long collection of *C. chapmanii,* and Dr. Svenson identified our specimen of *C. pallescens.*

For the most-frequently collected species, *C. lurida,* I have examined specimens from 83 of the 100 old counties of Virginia, counties before the incorporation of Elizabeth City, Norfolk, Princess Anne, and Warwick counties as the cities of Hampton, Norfolk and Chesapeake, Virginia Beach, and Newport News. On the other hand, eight species have apparently been collected in but a single county: *C. chapmanii,* Greensville; *C. extensa,* Norfolk; *C. pallescens,* Grayson; *C. polymorpha,* Rockingham; *C. rostrata,* Bath; *C. tetanica,* Sussex; *C. trichocarpa,* Washington; and *C. woodii,* Shenandoah County.

I have seen specimens for all included records with the exceptions of *C. biltmoreana* and *C. cherokeensis,* and these are based on the authority of the *Manual of the Vascular Flora of the Carolinas* (Radford, A. E., *et al.* 1968).

The 121 Virginia species of the carices grow in the following patterns:

1. Circumboreal.

C. brunnescens (Pers.) Poir.
C. buxbaumii Wahl.
C. canescens L. (also Australia)
C. lasiocarpa Ehrh.
C. muricata L.
C. pallescens L.
C. rostrata Stokes

2. North America and eastern Asia.

C. pedunculata Muhl.
C. pensylvanica Lam.

3. Ranging west to the Pacific Coast.

C. brevior (Dewey) Mackenz.
C. comosa Boott
C. eburnea Boott
C. hystricina Muhl.
C. interior Bailey
C. leptalea Wahl.
C. nigromarginata Schwein.
C. scoparia Schk.
C. stipata Muhl.
C. umbellata Schk.
C. vulpinoidea Michaux

4. Ranging southward beyond the United States.

C. albolutescens Schwein.
C. bromoides Schk.
C. lurida Wahl.
C. physorhyncha Lieb.

5. Extending inland to the Middle West.

a. Generally distributed in the north and south.

C. amphibola Steudel
C. artitecta Mackenz.
C. atlantica Bailey
C. blanda Dewey
C. caroliniana Schwein.
C. cephalophora Muhl.
C. complanata Torrey & Hooker
C. debilis Michaux
C. digitalis Willd.
C. emmonsii Dewey
C. festucacea Schk.
C. folliculata L.
C. frankii Kunth
C. granularis Muhl.
C. grisea Wahl.
C. howei Mackenz.
C. intumescens Rudge
C. jamesii Schwein.
C. laevivaginata (Küken.) Mackenz.
C. laxiflora Lam.
C. leavenworthii Dewey
C. lupuliformis Sartwell
C. lupulina Schk.
C. muhlenbergii Schk.
C. oligocarpa Schk.
C. retroflexa Muhl.
C. rosea Schk.
C. sparganoides Muhl.
C. *striatula* Michaux
C. stricta Lam.
C. styloflexa Buckley
C. tribuloides Wahl.
C. typhina Michaux
C. willdenowii Schk.

b. Generally northern in distribution.

C. albursina Sheldon
C. annectens Bicknell
C. argyrantha Tuckerm.
C. bushii Mackenz.
C. careyana Torrey
C. communis Bailey
C. conjuncta Boott
C. crinita Lam.
C. cristatella Britton
C. gracilescens Steudel

C. gracillima Schwein.
C. grayii Carey
C. hitchcockiana Dewey
C. laxiculmis Schwein.
C. leptonervia Fernald
C. normalis Mackenz.
C. plantaginea Lam.
C. platyphylla Carey
C. prasina Wahl.
C. scabrata Schwein.
C. shortiana Dewey
C. squarrosa L.
C. suberecta (Olney) Britton
C. swanii (Fernald) Mackenz.
C. tenera Dewey
C. tetanica Schk.
C. torta Boott
C. trichocarpa Muhl.
C. trisperma Dewey
C. virescens Muhl.

c. Generally southern in distribution.

C. cherokeensis Schwein.
C. crebriflora Weigand
C. flaccosperma Dewey
C. oxylepis Torrey & Hooker

d. Coastal plain and Mississippi Valey, extending westward in the northern states.

C. alata Torrey
C. decomposita Muhl.
C. hyalinolepis Steudel
C. seorsa Howe

e. Coastal plain and Mississippi Valley, extending westward in the south.

C. abscondita Mackenz.
C. crus-corvi Shuttl.
C. gigantea Rudge
C. glaucescens Elliott
C. joori Bailey
C. louisianica Bailey
C. reniformis (Bailey) Small

6. Limited to eastern North America.

a. Generally distributed north and south.

(1) Mostly on the coastal plain. *C. walteriana* Bailey.

(2) Mostly on the coastal plain but extending inland in the south.

C. barrattii Schwein. & Torrey
C. bullata Schk.
C. collinsii Nuttall
C. venusta Dewey

b. Plants mostly of northern distribution.

C. aestivalis M. A. Curtis
C. baileyi Britton
C. polymorpha Muhl.
C. vestita Willd.
C. woodii Dewey

c. Southern species. *C. chapmanii* Steudel

7. Southern Appalachian endemics.

C. biltmoreana Mackenz.

Cymophyllus fraseri (Andrz.) Mackenz.

8. Introduced species.

C. arenaria L. Europe

C. divisa Hudson Europe

C. extensa Good. Europe

C. kobomugi Ohwi e. Asia

C. spicata Hudson Eurasia

It is clear from this analysis that the vast majority of Virginia species are limited in range to the eastern part of North America, and it is probable that most of them had their origin here. This picture is not a true representation of the Virginia flora as a whole, however, because, as stated earlier, the carices are predominantly species of temperate regions of the Northern Hemisphere. If the other genera of sedges were included in this study, the picture would more nearly approximate that of the entire flora because most of those genera have strong tropical affinities. Among their species are many aggressive, opportunistic types which are, nevertheless, virtually confined to our coastal plain. The piedmont here becomes a formidable barrier to the spread of these species, apparently because of topography (and lack of many types of habitats), soils, and even the vegetation itself. The closed oak-hickory-pine communities, growing on "tight," clayey soils, are not communities through which many species can spread (Braun, 1950, p. 510). Some of these relationships are strikingly brought out by the distributional patterns within Virginia.

Within the state of Virginia, *Carex intumescens* has the widest range of all the 121 species, growing not only at sea level near the coast, but across the state and to the top of Mt. Rogers at 5719 feet. At the other extreme are the seven native species, each known from a single county; and although some of them may very well turn up elsewhere, we can be sure that they have very narrow environmental tolerances.

The 116 native species show the following patterns within the state:

1. Generally distributed across the state. (44 species)

2. Coastal plain. (20 species)

C. barrattii	*C. hyalinolepis*
C. bullata	*C. joori*
C. chapmanii	*C. louisianica*
C. cherokeensis	*C. lupuliformis*
C. collinsii	*C. oxylepis*
C. crus-corvi	*C. reniformis*
C. decomposita	*C. tetanica*
C. gigantea	*C. venusta*
C. glaucescens	*C. vestita*
C. howei	*C. walteriana*

3. Piedmont. *C. bushii*

4. Coastal plain and piedmont. (7 species)

C. alata	*C. grayi*
C. comosa	*C. typhina*
C. conjuncta	*C. umbellata*
C. emmonsii	

5. Mountains. (20 species)

C. aestivalis	*C. muricata*
C. albursina	*C. pallescens*
C. argyrantha	*C. pedunculata*
C. biltmoreana	*C. polymorpha*
C. brevior	*C. rostrata*
C. brunnescens	*C. suberecta*
C. careyana	*C. trichocarpa*
C. eburnea	*C. trisperma*
C. hystricina	*C. woodii*
C. leptonervia	*Cymophyllus fraseri*

6. Mountains and piedmont. (9 species)

C. communis	*C. interior*
C. cristatella	*C. plantaginea*
C. hitchcockiana	*C. shortiana*

C. sparganoides
C. torta
C. willdenowii

7. **Disjunct.** (15 species)

a. Coastal plain — mountains.

C. albolutescens
C. baileyi
C. bromoides
C. buxbaumii
C. canescens
C. folliculata
C. lasiocarpa
C. leptalea
C. oligocarpa
C. seorsa
C. virescens

b. Mountains — piedmont outlier (calcareous soils)
C. scabrata

c. Mountains — piedmont outlier (calcareous soils) — coastal plain (on marl) *C. jamesii* and *C. prasina*

d. Mountains — coastal plain (connected via the northern piedmont) *C. swanii*

These data show that almost 13% of the 116 native species have ranges with major discontinuities. Those with the most pronounced breaks are the coastal plain — mountain disjuncts. Of these eleven species, three have their larger populations on the coastal plain: *C. albolutescens, C. folliculata,* and *C. seorsa.* Four are more widespread in the mountains: *C. baileyi, C. leptalea, C. oligocarpa,* and *C. virescens.* The distribution of the four other species is about evenly balanced between the two areas: *C. bromoides, C. buxbaumii, C. canescens,* and *C. lasiocarpa.* For two of the last group, *C. buxbaumii* and *C. lasiocarpa,* we have collections from only two counties for each in the state, and oddly enough, in both cases they are at Big Meadows on the Blue Ridge in Madison County and the savanna-like swales of Sussex County on the coastal plain. It is also noteworthy that Big Meadows is one of the few locales in the state for *Campanula aparinoides* Pursh. The rare collections of the marsh-bellflower all come from our mountains except one from an amazingly isolated pocket, dis-

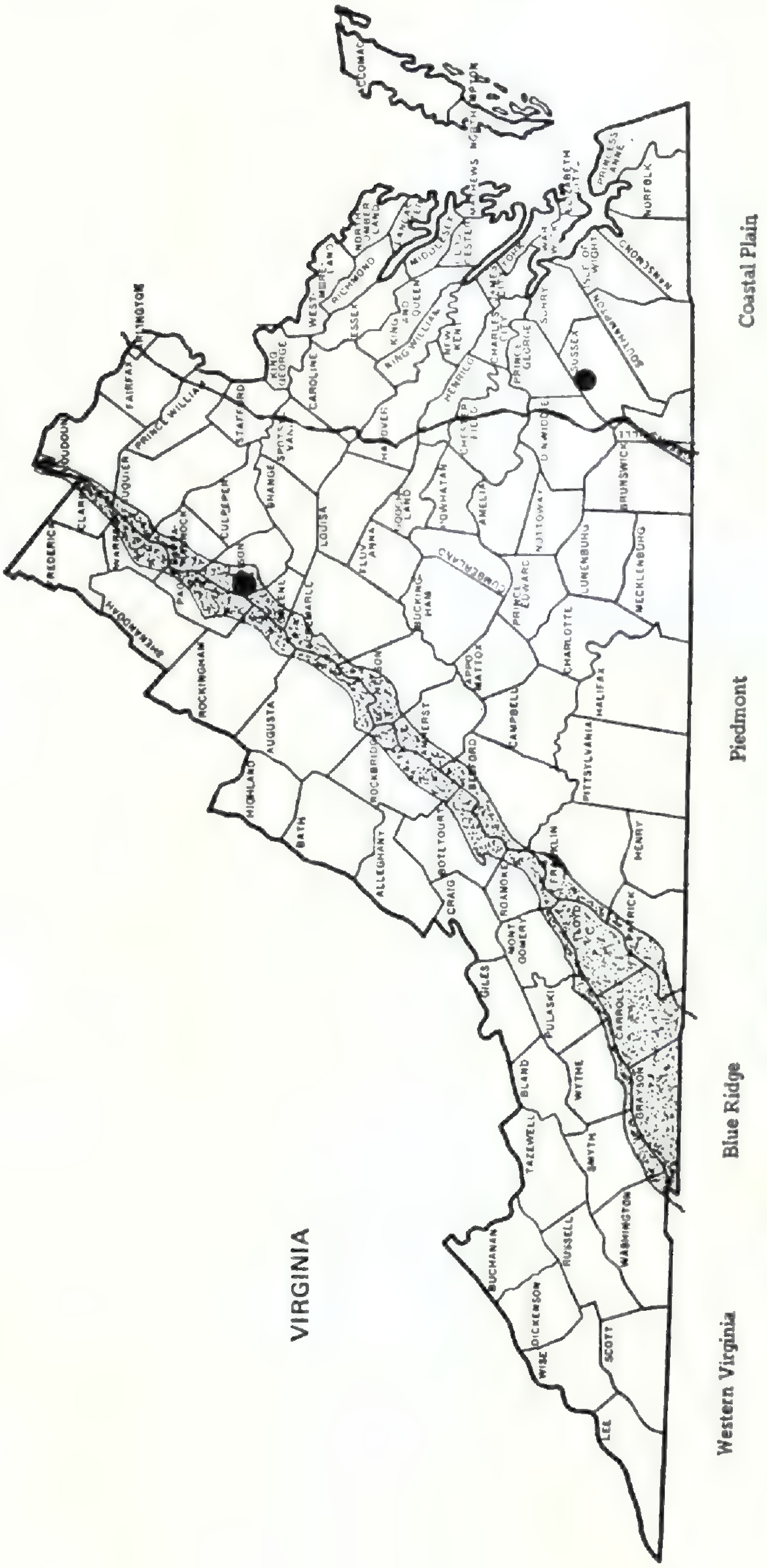


Fig. 1. Dots describe disjunct pattern of populations of *Carex buxbaumii* and *C. lasiocarpa* in Virginia.

covered by Fernald, around a sandy, sphagnous springhead almost at sea level and, again, in Sussex County. (Fig. 1).

Big Meadows is now the only station in Virginia for *Sanguisorba canadensis* L., yet, 10,000 to 12,000 years ago the Canadian burnet was a significant member of the vegetation in the Dismal Swamp area when spruce, pine, birch, alder, *Lycopodium lucidulum* Michaux, and *L. clavatum* (Whitehead, 1965) were other prominent members of this vegetation.

In his phytogeographic considerations of the coastal plain flora of Virginia, Fernald (1937) states, "Some students maintain that Coastal Plain species are moving into the ancient uplands. . . . however, it seems to me more probable that plants and animals of long-established and conservative groups should have moved out from the ancient lands . . ." Later he quotes Pennell on these disjunctions: "Certain it is that our study of the relations of the Southern Appalachians and Coastal Plain have shown that migrations may occur in either direction." Since Fernald, Pennell, and many more, in fact, considered this problem, the paleobotanical work of Craig (1969), Knox (1969), Whitehead, and others has thrown considerable light on plant migrations in this region (Harvill, 1972). These records of fossils clearly indicate that climatic oscillations of Pleistocene and Recent times brought plants migrating to and fro across the state. And it is reasonable to believe that with such climatic reversal, some species with narrow environmental tolerances would lose major portions of their ranges, whereas other species could persist in a few isolated areas where there are some unusual combinations of environmental factors. Therefore, it appears that the odd and disjunct ranges of these plants have most probably come about through the interplay between widespread climatic oscillations and local environmental conditions related to soils and sites, with both of these complexes of factors acting upon the tolerances of populations of these species which now have such discontinuous distributional patterns.

LITERATURE CITED

BRAUN, E. LUCY. 1950. Deciduous forests of eastern North America. Philadelphia, Blakiston Co. 596 pp.

CRAIG, A. J. 1969. Vegetational history of the Shenandoah Valley, Virginia. Geol. Soc. Am. Spec. Paper 123: 283-296.

FERNALD M. L. 1937. Local plants of the inner coastal plain of southeastern Virginia. Rhodora **39**: 465-491.

HARVILL, A. M. 1972. The historical significance of some disjunct distributional patterns in Virginia. Castanea **37**: 137-140.

HOOKER, J. D. 1862. Outlines of the distribution of arctic plants. Trans. Linn. Soc. London **23**: p. 283.

KNOX, A. S. 1969. Glacial age marsh, Lafayette Park, Washington, D. C. Science **165**: 795-797.

WHITEHEAD, D. R. 1965. Palynology and Pleistocene phytogeography of unglaciated eastern North America. *In* Wright, H. E. and D. G. Frey (eds.), The Quaternary of the United States. Princeton Univ. Press Princeton pp. 417-432.

LONGWOOD COLLEGE
FARMVILLE, VIRGINIA 23901

THE MARINE ALGAE OF VIRGINIA AND MARYLAND INCLUDING THE CHESAPEAKE BAY AREA[1, 2]

Franklyn D. Ott

INTRODUCTION

Until 1965 there existed no publication treating any aspect of the benthic or attached marine algae of the coast of Virginia and Maryland including the Chesapeake Bay area. Prior to this date only minor references to particular species for this area can be found in the literature. This paucity of research can be attributed, in the main, to the lack of solid substrata permitting prolonged and extensive development of algal populations. Time spent on more favorable habitats such as the rocky shores of the New England coast offer, to the phycologist, far more rewarding results for his endeavors.

The areas of the Virginia and Maryland coast facing directly upon the Atlantic are unstable, constantly moving, wave washed, sandy beaches. Behind the so-called Barrier Islands lie thousands of acres of *Spartina* salt marshes. In the shallow bays, between the Barrier Islands and the mainland, are abundant oyster reefs which offer a more stable substratum for algal growth. Since, however, the waters of these bays may reach temperatures in excess of 30°C during the summer only a limited number of algal taxa are to be found. The muddy bottoms of these bays, among the oyster reefs, offer a continuous supply of sediments which are constantly kept in suspension by the tidal currents. Consequently, light penetration is not great. Even in shallow waters it is virtually impossible to visually locate the algal populations.

[1]This work is a result of research sponsored by NOAA Office of Sea Grant, Department of Commerce, under Grant #1-36032 to the Virginia Institute of Marine Science.

[2]Virginia Institute of Marine Science Contribution No. 429.

In contrast to the higher salinities of the Atlantic coast, the Chesapeake Bay is a considerably more brackish area with salinities dropping significantly as one proceeds northward. Some stretches of sandy beaches do exist but they are subjected to less wave action than those of the Atlantic. Again *Spartina* salt marshes border extensive areas of the bay. The lower salinities, especially in the upper bay, exclude a great number of marine algal taxa. Some areas of the bay locally support a typical freshwater algal flora because of the steady and constant influx of fresh water. The upper reaches of all the estuaries are continually pouring into the water system a freshwater algal population. While such freshwater algal populations are not actively growing and will not long survive at the higher salinities, they often will be encountered on the microscopical examination of water samples. Their contribution to the overall ecology of the area can only be speculative at the present state of our knowledge.

Into this inhospitable habitat for marine algae man has constructed wood and rock jetties, breakwaters, piers, retaining walls, groins, and other structures. These offer a satisfactory, however unnatural, substrate for algal growth which are almost immediately colonized by algae. These types of man-made structures offer to the investigator an opportunity, with a reasonable expenditure of energy, to secure some insight into the composition of the algal population.

In 1965 the first significant publication on algae in this area appeared. Zaneveld and Barnes (1965) reported on the annual periodicity of the marine algae in the lower Chesapeake Bay. In the six following years, several papers have appeared reporting the algal flora of a particular rock jetty, geographical area, or habitat. In no case, however, does any of these published papers give an accurate picture of the wide variety of marine algae to be encountered in the states of Virginia and Maryland. In fact, many papers because of their limited scope leave the reader under the

false impression that the algal flora is far less diverse than it actually is.

This paper presents the results of a survey I initiated in September 1970, to establish the composition, abundance, location and periodicity of marine algae in Virginia and Maryland. These types of information were particularly desirable for us to accrue in view of: 1) the economic importance of the area's fishing industries which ultimately depend upon, and are affected by, the photosynthetic entities of the marine environment; 2) the ever-increasing pollution of the Chesapeake Bay and its estuaries; pollution which may affect the absolute and relative composition of the photosynthetic entities; and 3) the need to have at hand a ready store of pertinent information to investigate and to consider more intelligently the various ecological factors affecting the local marine environment. This paper represents a small step in the realization of these goals.

The following treatment presents a synoptic survey of the marine algae species reported for the states of Virginia and Maryland. No attempt has been made to describe morphologically or taxonomically the various species in the area under study. However, an attempt has been made to bring together, in a single work for the investigator, a summation of our current knowledge concerning the composition of the marine algal populations and to give their geographical distribution.

In the following the names for the plant divisions have been taken from Bold (1967). The names of families have been drawn, with a single minor exception, from Papenfuss (1955).

In the Division Cyanophycophyta no attempt has been made to relegate to synonymy the algal names as determined by the classical, standard works with those new names recently proposed by Drouet and Daily (1965) and Drouet (1968), nor does it seem desirable to do so in view of the fact that the authors have not given detailed opinions for their reduction of literally thousands of taxa to less than 20 genera. This has resulted in several cyanophy-

cean algae being entered under two different names. This situation is, however, compatible with the basic aim of this paper, namely a summation of the algal taxa reported for the area.

All specimens cited, without reference to a publication, are deposited in the herbarium of the Virginia Institute of Marine Science. Specimen citations taken from a publication follow the reference.

DIVISION CHLOROPHYCOPHYTA

Family ZYGNEMATACEAE (Meneghini) Kützing orth. mut. Engler (essentially freshwater species)

Spirogyra sp.: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Family DESMIDIACEAE Kützing ex Ralfs orth. mut. Stizenberger

Closterium gracile Brébisson: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Staurastrum sp.: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Family ULOTRICHAECEAE Kützing orth. mut. Rabenhorst

Ulothrix endosporangia Humm nom. prov.: VIRGINIA: *H. J. Humm,* York River at Gloucester Point and throughout the immediate general area.

Ulothrix flacca (Dillwyn) Thuret: VIRGINIA: *F. D. Ott,* York River at Gloucester Point. Wulff (1967), York River at Gloucester Point. Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *F. D. Ott,* on piling at Ocean City. Mathieson and Fuller (1969), pilings at Chesapeake Biological Laboratory boathouse, mouth of Patuxent River at Drum Point, abandoned Cedar Point Light House.

Ulothrix subflaccida Wille: VIRGINIA: *S. Ramsey,* York River at Gloucester Point.

Ulothrix sp.: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Family CHAETOPHORACEAE Harvey orth. mut. Stizenberger

Entocladia viridis Reinke: VIRGINIA: *H. J. Humm,* on

Grinnellia americana from the northern end of Willoughby Spit near Hampton Roads; *F. D. Ott,* on *Grinnellia americana* from the York River at Gloucester Point.

Entocladia wittrockii Wille: VIRGINIA: *J. Vogel et H. J. Humm,* on *Fucus vesiculosus* from salt marshes along Hummock Channel, Wachapreague.

Protoderma marinum Reinke: VIRGINIA: *Leg. H. J. Humm,* York River in Guinea Marshes.

Pseudodendroclonium marinum (Reinke) Aleem et Schulz: MARYLAND: Mathieson and Fuller (1969), abandoned Cedar Point Light House, beach between Cedar Point and Point No Point south of Patuxent River mouth.

Family MONOSTROMACEAE Kunieda ex Suneson

Monostroma leptodermum Kjellman: VIRGINIA: Wulff (1967), York River at Gloucester Point. Wulff and Webb (1969), York River at Gloucester Point.

Monostroma oxyspermum (Kützing) Doty: VIRGINIA: *H. J. Humm,* York River at Gloucester Point; *F. D. Ott,* Chincoteague Inlet at Chincoteague. MARYLAND: Mathieson and Fuller (1969), shore of Patuxent River on rocks of retaining wall of Naval Base Property.

Monostroma sp.: VIRGINIA: Rhodes (1970), Burton's Bay near Wachapreague.

Family ULVACEAE Lamouroux orth. mut. Dumortier

Enteromorpha clathrata (Roth) J. Agardh: VIRGINIA: *H. J. Humm,* York River near Gloucester Point; *F. D. Ott,* Burton's Bay near Wachapreague. Mangum, Santos and Rhodes (1968), York River at Sandy Point. MARYLAND: *F. D. Ott,* on *Spartina* stems in marsh area south of jetty. Mathieson and Fuller (1969), beach on south shore of Patuxent River west of entrance to Naval Seaplane Harbor.

Enteromorpha compressa (Linnaeus) Greville: VIRGINIA: *M. Lynch,* York River at Gloucester Point; *Leg. B. L. Wulff,* York River at Yorktown; *Leg. F. D. Ott,* Chesapeake Bay at Cape Charles. Wulff (1967), York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River at Sandy Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *J. K. Lowry, B. H. Robi-*

son, and *B. L. Wulff*, north jetty at Ocean City; *Leg. F. D. Ott*, on shells in marsh area just south of jetty. Wulff *et al* (1968), jetty at Ocean City.

Enteromorpha erecta (Lyngbye) J. Agardh: VIRGINIA: Wulff (1967), York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River at Sandy Point; Wulff and Webb (1969), York River at Gloucester Point.

Enteromorpha intestinalis (Linnaeus) Link: VIRGINIA: Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff*, north jetty at Ocean City. Zaneveld (1966-67), *sine locus;* Wulff *et al* (1968), jetty at Ocean City; Mathieson and Fuller (1969), beach on south shore of Patuxent River just west of entrance to Naval Station seaplane harbor, Drum Point at mouth of Patuxent River, #5 beacon at mouth of Patuxent River, rock retaining wall on Naval Base property on south shore of Patuxent River, abandoned Cedar Point Light House, Cover Point just north of Patuxent River mouth, beach north of Cove Point, 1.5 miles east of Bloodsworth Island, channel between James Island and Red Nun #2, Kent Narrows and Piney Narrows Marina, Chester River off Cedar Point, Patuxent River off Half Pone Point, Patuxent River west of Broomes Island.

Enteromorpha lingulata J. G. Agardh: VIRGINIA: *M. Wass*, York River at Gloucester Point.

Enteromorpha linza (Linnaeus) J. Agardh: VIRGINIA: *M. Wass*, York River at Gloucester Point; *Leg. M. Wass*, York River at Gloucester Point; *Leg. H. J. Humm*, York River at Gloucester Point. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *J. K. Lowry, B. H. Robison* and *B. L. Wulff*, north

jetty at Ocean City; *Leg. J. K. Lowry, B. L. Wulff* and *B. H. Robison,* north jetty at Ocean City; Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Enteromorpha marginata J. Agardh: VIRGINIA: Zaneveld (1966-67).

Enteromorpha micrococca Kützing: MARYLAND: *J. K. Lowry, B. L. Wulff,* and *B. H. Robison,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Enteromorpha minima Nägeli: VIRGINIA: *M. Wass,* York River at Gloucester Point; *Leg. H. J. Humm,* York River at Gloucester Point. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: Wulff *et al* (1968), jetty at Ocean City, Mathieson and Fuller (1969), mouth of Patuxent River at Drum Point, shore of Patuxent River at Naval Base property.

Enteromorpha plumosa Kützing: VIRGINIA: Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague.

Enteromorpha prolifera (Müller) J. Agardh: VIRGINIA: *M. Wass,* York River at Gloucester Point; *W. Dillon,* York River at Gloucester Point; *H. J. Humm,* Hummock Channel near Wachapreague; *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *J. K. Lowry, B. H. Robison,* and *B. L. Wulff,* north jetty at Ocean City; *F. D. Ott,* on oyster shells in marsh area just south of jetty. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City; Mathieson and Fuller (1969), Kent Narrows and Piney Narrows Marina.

Percursaria percursa (C. Agardh) J. Agardh: MARYLAND: Zaneveld (1966-67).

Ulva lactuca Linnaeus; VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Wulff (1967), York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River

at Sandy Point; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. L. Wulff, J. K. Lowry* and *B. H. Robison,* north jetty at Ocean City; *F. D. Ott,* on shells in shallow water at Ocean City. Wulff *et al* (1968), jetty at Ocean City; Mathieson and Fuller (1969), Patuxent River west of entrance to seaplane harbor, mouth of Patuxent River at Drum Point, Patuxent River on retaining wall of Naval Base property, beach midway between Cedar Point and Point No Point, south of Patuxent River mouth, beach north of Cove Point, Holland Strait off South Marsh Island, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound, 1.5 miles east of Bloodsworth Island, 1.25 miles southwest of Red Nun #2, between Poplar Island Narrows Light and Can #1, 900 yards east of Coaches Island, mouth of Crab Alley Bay off Parson and Bodkin Island, channel between James Island and Red Nun #2, east and west of Knapps Narrows, Kent Narrows and Piney Narrows Marina.

Ulva lactuca Linnaeus var. *latissima* (Linnaeus) de Candolle: VIRGINIA: *K. M. S. Aziz,* York River at Gloucester Point; *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld (1966-67). MARYLAND: *F. D. Ott,* adrift at Assateague Beach. Zaneveld (1966-67).

Ulva lactuca Linnaeus var. *rigida* (C. Agardh) Le Jolis: VIRGINIA: *F. D. Ott,* Chesapeake Bay at Cape Charles. Zaneveld (1966-67). MARYLAND: *F. D. Ott,* on rock at jetty in Ocean City.

Family CHLORELLACEAE (Wille) Brunnthaler

Chlorella sp.: MARYLAND: Morse (1947), mouth of Patuxent River. GENERAL: Griffith (1961), Chesapeake Bay, *D. C. Morse.*

Family GOMONTIACEAE Bornet et Flahault ex De Toni

Gomontia polyrhiza (Lagerheim) Bornet et Flahault: VIRGINIA: *H. J. Humm,* York River at Gloucester Point; *K. M. S. Aziz,* York River at Yorktown; *F. D. Ott,* Chesapeake Bay at Cape Charles. MARYLAND: *B. H. Robison,*

J. K. Lowry and *B. L. Wulff,* north jetty at Ocean City; *F. D. Ott,* Ocean City growing on *Spartina* stems.

Family HYDRODICTYACEAE (S. F. Gray) Dumortier orth. mut Cohn (essentially freshwater species)

Pediastrum boryanum (Turpin) Meneghini: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Pediastrum duplex Meyen: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Pediastrum simplex Meyen: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Family SCENEDESMACEAE Oltmanns (essentially freshwater species)

Actinastrum sp.: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Scenedesmus acuminatus (Lagerheim) Chodat: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Scenedesmus opaliensis P. Richter: GENERAL: Griffith (1961), Chesapeake Bay, *R. C. Whaley.*

Scenedesmus quadricauda (Turpin) in de Brébisson et Godey: VIRGINIA: Marshall (1967), Elizabeth River.

Scenedesmus sp.: VIRGINIA: Marshall (1967), Elizabeth River.

Family CLADOPHORACEAE (Hassell) Cohn

Chaetomorpha aerea (Dillwyn) Kützing: MARYLAND: Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Chaetomorpha linum (Müller) Kützing: VIRGINIA: *H. J. Humm,* York River in the Guinea Marshes; *B. L. Wulff,* York River off Wormley Creek. Marsh (1970), York River.

Cladophora albida (Hudson) Kützing: VIRGINIA: *F. D. Ott,* Chesapeake Bay at Cape Charles. Zaneveld (1966-67).

Cladophora crystallina (Roth) Kützing: VIRGINIA: Zaneveld (1966-67).

Cladophora expansa (Mertens) Kützing: VIRGINIA: Zaneveld (1966-67).

Cladophora fascicularis (Mertens) Kützing: VIRGINIA: *H. J. Humm,* Hampton Roads at Norfolk; *M. Wass,* York River at Gloucester Point.

Cladophora flexuosa (Dillwyn) Harvey: VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld and Barnes (1965), lower Chesapeake Bay. MARYLAND: Mathieson and Fuller (1969), Patuxent River at Broomes Island.

Cladophora flexuosa (Dillwyn) Harvey forma *densa* Collins: VIRGINIA: Zaneveld (1966-67). MARYLAND: Mathieson and Fuller (1969), Abandon Cedar Point Light House.

Cladophora gracilis (Griffith ex Harvey) Kützing: VIRGINIA: Zaneveld and Barnes (1965), lower Chesapeake Bay; Marsh (1970), York River. MARYLAND: *F. D. Ott,* in quiet water in marshes south of Ocean City. Mathieson and Fuller (1969), Cove Point just north of Patuxent River mouth, beach north of Cove Point, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound.

Cladophora magdalenae Harvey: VIRGINIA: *H. J. Humm,* York River in the Guinea Marshes.

Cladophora rupestris (Linnaeus) Kützing: VIRGINIA: *M. Wass,* York River at Gloucester Point; *F. D. Ott,* Burton's Bay near Wachapreague.

Rhizoclonium kockianum Kützing: VIRGINIA: *H. J. Humm,* York River at Gloucester Point.

Rhizoclonium riparium (Roth) Harvey: VIRGINIA: *H. J. Humm,* York River at Gloucester Point. Zaneveld (1966-67). MARYLAND: Mathieson and Fuller (1969), pilings at Chesapeake Biological Laboratory boathouse.

Rhizoclonium tortuosum Kützing: VIRGINIA: *H. J. Humm,* Hummock Channel at Wachapreague.

Family BRYOPSIDACEAE Bory de Saint-Vincent orth. mut. De Toni

Bryopsis hypnoides Lamouroux: VIRGINIA: *F. D. Ott,* James River at north end of James River Bridge. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Mangum, Santos and Rhodes (1968), York River at Sandy Point. MARYLAND: *F. D. Ott,* on pilings at Ocean City. Zaneveld (1966-67).

Bryopsis plumosa (Hudson) C. Agardh: VIRGINIA: *W.*

Dillon, York River at Gloucester Point; P. E. Hargraves, York River at Gloucester Point; *F. D. Ott,* Hampton Roads at Fort Monroe. Zaneveld and Barnes (1965), lower Chesapeake Bay; Wulff (1967), York River at Gloucester Point; Zaneveld (1966-67); Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* on pilings at Ocean City. Zaneveld (1966-67).

DIVISION PHAEOPHYCOPHYTA

Family ECTOCARPACEAE (C. Agardh) Kützing orth. mut. Harvey

Ectocarpus confervoides (Roth) Le Jolis: VIRGINIA: *M. Wass,* Sarah's Creek below Gloucester Point; *F. D. Ott,* York River at Sandy Point. Zaneveld (1966-67); Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *F. D. Ott,* Ocean City, in marsh area just south of jetty. Zaneveld (1966-67).

Ectocarpus elachistaeformis Heydrich: VIRGINIA: *H. J. Humm,* York River at Gloucester Point.

Ectocarpus penicillatus (C. Agardh) Kjellman: VIRGINIA: Mangum, Santos and Rhodes (1968), York River at Sandy Point.

Ectocarpus siliculosus (Dillwyn) Lyngbye: VIRGINIA: *M. Wass,* York River at Sandy Point; *M. Wass,* York River at Gloucester Point; *F. D. Ott,* Hampton Roads at Lynnhaven Inlet. Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Ocean City, in marsh area just south of jetty.

Giffordia duchassaigniana (Grunow) Taylor: MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Pylaiella littoralis (Linnaeus) Kjellman: VIRGINIA: Zaneveld (1966-67); Mangum, Santos and Rhodes (1968), York River at Sandy Point. MARYLAND: Zaneveld (1966-67).

Family SPHACELARIACEAE J. Agardh orth. mut. Cohn

Sphacelaria fusca (Hudson) C. Agardh: VIRGINIA: *F. D.*

Ott, York River at Gloucester Point. MARYLAND: Mathieson and Fuller (1969), Patuxent River 200 yards west of Broomes Island.

Family DICTYOTACEAE Lamouroux orth. mut. Dumortier

Dictyota dichotoma (Hudson) Lamouroux: VIRGINIA: *H. J. Humm,* Hummock Channel near Wachapreague. Humm (1963), Hummock Channel near Wachapreague; Rhodes (1970), Burton's Bay near Wachapreague.

Family MYRIONEMATACEAE (Nägeli) Foslie orth. mut. Skottsberg

Ascocyclus orbicularis Magnus: VIRGINIA: *H. J. Humm,* York River at Gloucester Point. Mangum, Santos and Rhodes (1968), York River at Sandy Point.

Myrionema stragulans Greville: VIRGINIA: Mangum, Santos and Rhodes (1968), York River at Sandy Point.

Family ELACHISTACEAE Kjellman

Elachistea facicola (Velley) Areschoug: VIRGINIA: *J. L. Wood,* adrift and epiphytic on *Fucus vesiculosus,* collected ca. 60 miles offshore from the mouth of the Chesapeake Bay.

Elachistea sp.: VIRGINIA: Marsh (1970), York River.

Family CORYNOPHLAEACEAE Oltmanns

Leathesia difformis (Linnaeus) Areschoug: VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld (1966-67); Rhodes (1970), Burton's Bay near Wachapreague.

Family SPERMATOCHNACEAE Kjellman

Stilophora rhizodes (Ehrhart) J. Agardh: VIRGINIA: *B. H. Wulff,* York River at Gloucester Point.

Family STRIARIACEAE Kjellman

Striaria attenuata (C. Agardh) Greville: VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Ocean City, in marsh area just south of jetty.

Family MYRIOTRICHIACEAE Kjellman

Myriotrichia subcorymbosa (Farlow emend. Holden) Blomquist: VIRGINIA: *H. J. Humm,* York River at Gloucester Point; *H. J. Humm,* York River at Gloucester Point.

Family PUNCTARIACEAE (Thuret) Kjellman

Desmotrichum undulatum (J. Agardh) Reinke: VIRGINIA: *F. D. Ott,* on *Zostera* at Cape Charles. Mangum, Santos and Rhodes (1968), York River at Sandy Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* on bent stems of *Spartina* in marsh area just south of jetty.

Petalonia fascia (O. F. Müller) Kuntze: VIRGINIA: *F. D. Ott,* on rocks at Chincoteague Inlet at Chincoteague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67). MARYLAND: *J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City; *F. D. Ott,* Ocean City, on stones of jetty. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Punctaria latifolia Greville: VIRGINIA: *F. D. Ott,* James River just north of James River Bridge. Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Ocean City, in marsh area just south of jetty.

Punctaria plantaginea (Roth) Greville: VIRGINIA: Zaneveld and Barnes (1965), lower Chesapeake Bay. MARYLAND: Zaneveld (1966-67).

Family SCYTOSIPHONACEAE (Thuret) Hauck

Asperococcus echinatus (Mertens) Greville: VIRGINIA: *F. D. Ott,* York River at Yorktown Beach. MARYLAND: *F. D. Ott,* Ocean City, in marsh area just south of jetty.

Scytosiphon lomenataria (Lyngbye) C. Agardh: VIRGINIA: *F. D. Ott,* Burton's Bay near Wachapreague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City; *F. D. Ott,* Ocean City on stones of jetty. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Family DICTYOSIPHONACEAE Kützing orth. mut. Kjellman

Dictyosiphon foeniculaceus (Hudson) Greville: VIRGINIA: Rhodes (1970), Burton's Bay near Wachapreague.

Family FUCACEAE Lamouroux orth. mut. Dumortier

Fucus vesiculosus Linnaeus: VIRGINIA: *J. Vogel,* Haven

Beach, just south of Milford Haven facing Chesapeake Bay; *H. J. Humm,* adrift in Little Creek, Norfolk; *K. de Witt,* washed ashore at Virginia Beach; *H. J. Humm,* Hummock Channel near Wachapreague; *F. D. Ott,* on rocks at Chincoteague Inlet at Chincoteague. Zaneveld (1966-67). Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Ocean City on rocks and at edge of salt marshes. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Fucus vesiculosus Linnaeus var. *sphaerocarpus* J. Agardh: MARYLAND: Zaneveld (1966-67).

Ascophyllum nodosum (Linnaeus) Le Jolis: VIRGINIA: *F. D. Ott,* adrift in Chincoteague Inlet at Chincoteague. Zaneveld (1966-67), *sine locus.* MARYLAND: *F. D. Ott,* Ocean City, abundant in the wash in October 1971. Zaneveld (1966-67).

Ascophyllum nodosum (Linnaeus) Le Jolis forma *scorpioides* (Hornemann) Reinke: MARYLAND: *J. K. Lowry* and *B. H. Robison,* found attached to the north jetty at Ocean City.

Family SARGASSACEAE (Decaisne) Kützing orth. mut. De Toni

Sargassum natans (Linnaeus) J. Meyen: VIRGINIA: *F. D. Ott,* Burton's Bay near Wachapreague. Zaneveld (1966-67). MARYLAND: *F. D. Ott,* Ocean City, abundant in the wash during November-December 1971. Zaneveld (1966-67).

Sargassum hystrix J. Agardh var. buxifolium (Chauvin) J. Agardh: VIRGINIA: *F. D. Ott,* adrift at Hampton Roads at Lynnhaven Inlet. Zaneveld (1966-67). MARYLAND: *F. D. Ott,* Assateague Beach, abundant in the wash during November-December 1971.

DIVISION RHODOPHYCOPHYTA

Family GONIOTRICHACEAE Skuja

Goniotrichum alsidii (Zanardini) Howe: VIRGINIA: Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: Wulff *et al* (1968), jetty at Ocean City.

Family ERYTHROPELTIDACEAE Skuja

Erythrocladia subintegra Rosenvinge: VIRGINIA: *H. J. Humm,* York River at Gloucester Point.

Erythrotrichia rhizoides Cleland: VIRGINIA: Rhodes (1970), Burton's Bay near Wachapreague.

Family BANGIACEAE (S. F. Gray) Nägeli

Bangia ciliaris Carmichael: MARYLAND: *B. L. Wulff, J. K. Lowry* and *B. H. Robison,* north jetty at Ocean City; mixed in with herbarium sample of *Acrochaetium trifilum.*

Bangia fuscopurpurea (Dillwyn) Lyngbye: VIRGINIA: *F. D. Ott,* Virginia Beach on stones of jetty south of resort area. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *B. L. Wulff, B. H. Robison* and *J. K. Lowry,* north jetty at Ocean City; *F. D. Ott,* Ocean City on rocks in marsh area just south of jetty. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Porphyra leucosticta Thuret: VIRGINIA: *K. de Witt,* Lynnhaven Inlet; *P. E. Hargraves,* York River at Gloucester Point. Zaneveld and Barnes (1965), lower Chesapeake Bay; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. L. Wulff, B. H. Robison* and *J. K. Lowry,* north jetty at Ocean City; *F. D. Ott,* Ocean City on stones of jetty. Wulff *et al* (1968), jetty at Ocean City.

Porphyra miniata (Lyngbye) C. Agardh: VIRGINIA: *H. J. Humm,* Hummock Channel near Wachapreague. Rhodes (1970), Burton's Bay near Wachapreague.

Porphyra umbilicalis (Linnaeus) J. Agardh: VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Family ACROCHAETIACEAE Fritsch

Acrochaetium alcyonidii Jao: VIRGINIA: *K. M. S. Aziz,* York River at Gloucester Point.

Acrochaetium dasyae Collins: VIRGINIA: *D. Dilliman,* James River above Gum Rock.

Acrochaetium flexuosum Vickers: MARYLAND: Mathieson and Fuller (1969), Patuxent River west of Broomes Island.

Acrochaetium radiatum Jao: MARYLAND: *B. L. Wulff, J. K. Lowry* and *B. H. Robison,* jetty at Ocean City.

Acrochaetium trifilum (Buffham) Batters emend. Aziz: MARYLAND: *B. L. Wulff, J. K. Lowry* and *B. H. Robison,* north jetty at Ocean City; *B. L. Wulff, J. K. Lowry* and *B. H. Robison,* north jetty at Ocean City; *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Acrochaetium virgatulum (Harvey) J. Agardh: MARYLAND: Wulff *et al* (1968), jetty at Ocean City.

Acrochaetium virgatulum (Harvey) J. Agardh forma *luxurians* (J. Agardh) Collins: VIRGINIA: *M. Wass,* York River at Gloucester Point.

Acrochaetium spp.: MARYLAND: Wulff *et al* (1968), jetty at Ocean City.

Family HELMINTHOCLADIACEAE (J. Agardh) Harvey orth. mut. Hauck

Nemalion multifidum (Weber et Mohr) J. Agardh: MARYLAND: *J. K. Lowry* and *B. H. Robison,* north jetty at Ocean City; *E. M.* and *B. H. Wulff,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Family BONNEMAISONIACEAE Schmitz *in* Engler

Asparagopsis hamifera (Hariot) Okamura: It has been established that the two independently described algae, *Asparagopsis hamifera* and *Trailliella intricata,* are respectively the gametophytic and tetrasporophytic plants of an alga having a heteromorphic alternation of generations. While the gametophytic *Asparagopsis hamifera* has not been recorded for the geographical area under study, the tetrasporophytic *Trailliella intricata* has been found. This plant has been entered in this compilation under the

Ceramiaceae where it was assigned prior to the establishment of its relationship with *Asparagopsis hamifera*.

Family GELIDIACEAE Kützing orth. mut. Harvey

Gelidium crinale (Turner) Lamouroux: VIRGINIA: *M. Lynch*, jetty at Little Creek in Norfolk; *H. J. Humm*, York River at Yorktown; *F. D. Ott*, Chesapeake Bay at Cape Charles on stones of jetty. Zaneveld and Barnes (1965), lower Chesapeake Bay; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott*, Ocean City on rocks of jetty.

Family CORALLINACEAE (Lamouroux) Harvey

Fosliella farniosa (Lamouroux) Howe: VIRGINIA: *H. J. Humm*, York River at Gloucester Point.

Fosliella lejolisii (Rosanoff) Howe: VIRGINIA: Marsh (1970), York River.

Family SOLIERIACEAE (Harvey) Hauck

Agardhiella tenera (J. Agardh) Schmitz: VIRGINIA: *H. J. Humm*, York River at Gloucester Point; *K. M. S. Aziz*, York River at Gloucester Point; *P. E. Hargraves*, York River at Gloucester Point; *F. D. Ott*, Hampton Roads at Lynnhaven. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Mangum, Santos and Rhodes (1968), York River at Sandy Point; Mathieson and Fuller (1969), Gwynn Island 300 yards inshore of #1 beacon; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott*, Assateague Beach, abundant in wash. Zaneveld (1966-67).

Family HYPNEACEAE J. Agardh

Hypnea musciformis (Wulfen) Lamouroux: VIRGINIA: *H. J. Humm*, York River at Yorktown; *F. D. Ott*, Chesapeake Bay at Cape Charles on stones of jetty. Zaneveld (1966-67). Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott*, Ocean City in marsh area just south of jetty. Zaneveld (1966-67).

Family GRACILARIACEAE (Nägeli) Kylin

Gracilaria foliifera (Forsskål) Børgesen: VIRGINIA: *F. D. Ott*, Burton's Bay near Wachapreague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-

67); Mangum, Santos and Rhodes (1968), York River at Sandy Point; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. H. Robison* and *J. K. Lowry,* jetty at Ocean City; *F. D. Ott,* Ocean City on shells in marsh area just south of jetty. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Gracilaria verrucosa (Hudson) Papenfuss: VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Mathieson and Fuller (1969), Mobjack Bay off Guinea Marsh, Gwynn Island 300 yards inshore of #1 beacon; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* on stones in marsh area just south of jetty. Zaneveld (1966-67); Mathieson and Fuller (1969) beach midway between Cedar Point and Point No Point south of Patuxent River mouth, beach north of Cove Point, Holland Strait off South Marsh Island near #2 beacon, midway between #9 beacon and James Island Light off Crisfield, Great Rock Oyster Bar off James Island Light, Little Annemessex River at mouth of Battle Creek, Pocomoke Sound off Broad Creek, Shark Fin Shoal east of Bloodsworth Island, mouth of Patuxent River near Obstruction Buoy west of Drum Point, between Poplar Island Narrows Light and Can #1, Crab Alley Bay between Can #1 and Bodkin Island, channel between James Island and Red Nun #2, east and west of Knapps Narrows, Kent Narrows and pilings at Piney Narrows Marina.

Family GIGARTINACEAE Bory de Saint-Vincent orth. mut. Cohn

Chondrus crispus Stackhouse: VIRGINIA: Zaneveld (1966-67).

Family CHAMPIACEAE Kützing orth. mut. Bliding

Champia parvula (C. Agardh) Harvey: VIRGINIA: *K. M. S. Aziz,* York River at Gloucester Point; *M. Wass*, York River at Gloucester Point; *F. D. Ott,* Chesapeake Bay at Cape Charles. Zaneveld and Barnes (1965), lower Chesapeake Bay; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,*

Ocean City on shells in marsh area just south of jetty. Mathieson and Fuller (1969), Great Rock Oyster Bar south of James Island Light, Little Annemessex River and Pocomoke Sound, Pocomoke Sound off Broad Creek, Shark Fin Shoal east of Bloodsworth Island.

Lomentaria baileyana (Harvey) Farlow: VIRGINIA: *F. D. Ott,* Burton's Bay near Wachapreague. Rhodes (1970), Burton's Bay near Wachapreague.

Family CERAMIACEAE (S. F. Gray) Harvey orth. mut. Rabenhorst

Antithamnion cruciatum (C. Agardh) Nägeli: VIRGINIA: Rhodes (1970), Burton's Bay near Wachapreague.

Callithamnion baileyi Arnott: VIRGINIA: *B. L. Wulff,* York River at Gloucester Point. Zaneveld (1966-67). MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Callithamnion byssoides Arnott: VIRGINIA: *M. Lynch,* jetty in Little Creek in Norfolk; *H. J. Humm,* Hummock Channel near Wachapreague; *F. D. Ott,* Burton's Bay near Wachapreague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Assateague Beach adrift in wash.

Callithamnion corymbosum (Smith) C. Agardh: VIRGINIA: *F. D. Ott,* Chincoteague Inlet at Chincoteague. Rhodes (1970), Burton's Bay near Wachapreague.

Ceramium diaphanum (Lightfoot) Roth: VIRGINIA: Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Marsh (1970), York River. MARYLAND: Zaneveld (1966-67), *sine locus.*

Ceramium fastigiatum (Roth) Harvey: VIRGINIA: *M. Wass,* mouth of Chesapeake Bay; *F. D. Ott,* Chesapeake Bay at Cape Charles, on stones of jetty. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Marsh (1970), York River; Rhodes (1970), Burton's

Bay near Wachapreague. MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff*, north jetty at Ocean City; *F. D. Ott*, Assateague Beach abundant in wash. Wulff *et al* (1968), jetty at Ocean City.

Ceramium rubriforme Kylin: VIRGINIA: Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague.

Ceramium rubrum (Hudson) C. Agardh: VIRGINIA: *B. L. Wulff*, York River at Yorktown; *P. E. Hargraves*, adrift in the York River at Gloucester Point; *F. D. Ott*, Chesapeake Bay at Cape Charles. Woodson (1959), mouth of James River; Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River at Sandy Point; Mathieson and Fuller (1969); Mobjack Bay off Guinea Marsh; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *J. K. Lowry, B. L. Wulff* and *B. H. Robison*, north jetty at Ocean City; *F. D. Ott*, Assateague Beach, abundant in the wash. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City; Mathieson and Fuller (1969), beach on south shore of Patuxent River just west of entrance to Naval Station seaplane harbor, rock retaining wall on Naval Base property south shore of Patuxent River, beach north of Cove Point, Holland Strait off South Marsh Island, midway between #9 beacon and James Island Light off Crisfield, Great Oyster Bar south of James Island Light, Little Annemessex River at mouth of Battle Creek, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound, Shark Fin Shoal east of Bloodsworth Island, 1.5 miles east of Bloodsworth Island, mouth of Patuxent River near Obstruction Buoy west of Drum Point, between Poplar Island Narrows Light and Can #1, Crab Alley Bay between Can #1 and Bodkin Island, channel between James Island and Red Nun #2, Kent Narows and pilings at Piney Narrows Marina, Chester River off Cedar Point, Patuxent River 200 yards west of Broomes Island.

Ceramium strictum (Kützing) Harvey: VIRGINIA: *M. Wass*, York River at Gloucester Point; *P. E. Hargraves*, adrift in the York River at Gloucester Point; *J. Vogel*, eastern side of Gwynn Island near mouth of the Rappahannock River. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River at Sandy Point; Mathieson and Fuller (1969), Mobjack Bay off Guinea Marsh; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River. MARYLAND: *B. L. Wulff, J. K. Lowry* and *B. H. Robison*, north jetty at Ocean City. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City; Mathieson and Fuller (1969), beach on shore of Patuxent River west of entrance to Naval Station seaplane harbor, rock retaining wall on Naval Base property south shore of Patuxent River, abandoned Cedar Point Light House, beach north of Cove Point, Holland Strait off South Marsh Island, midway between #9 beacon and James Island Light off Crisfield, Great Rock Oyster Bar south of James Island Light, Little Annemessex River at mouth of Battle Creek, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound, Pocomoke Sound off Broad Creek. Shark Fin Shoal east of Bloodsworth Island, 1.5 miles east of Bloodsworth Island, mouth of Patuxent River near Obstruction Buoy west of Drum Point, mouth of Crab Alley Bay off Parson Island and Bodkin Island, channel between James Island and Red Nun #2, off Half Pone Point, 200 yards west of Broomes Island.

Griffithsia tenuis C. Agardh: VIRGINIA: *H. J. Humm*, York River at Gloucester Point.

Spyridia filamentosa (Wulfen) Harvey: VIRGINIA: *F. D. Ott*, Chesapeake Bay at Cape Charles. Mangum, Santos and Rhodes (1968), York River at Sandy Point; Mathieson and Fuller (1969), Mobjack Bay off Guinea Marsh; Pocomoke Sound near Red Nun #6; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott*, Ocean City on shells in marsh area just

south of jetty. Mathieson and Fuller (1969), Holland Strait off South Marsh Island, midway between #9 beacon and James Island Light off Crisfield, Great Rock Oyster Bar south of James Island Light, Little Annemessex River at mouth of Battle Creek, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound, Pocomoke Sound off Broad Creek, between Red Nun #4 and Hooper Strait Light, mouth of Patuxent River near Obstruction Buoy west of Drum Point.

Trailliella intricata (J. Agardh) Batters: MARYLAND: Mathieson and Fuller (1969), Holland Strait off South Marsh Island, between #9 beacon and James Island Light off Crisfield, Great Rock Oyster Bar south of James Island Light, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound, Pocomoke Sound off Broad Creek, between Red Nun #4 and Hooper Strait Light.

Family DASYACEAE Kützing orth. mut. Rosenberg

Dasya pedicellata (C. Agardh) C. Agardh: VIRGINIA: *K. M. S. Aziz* and *J. Vogel,* Haven Beach, Mathews County; *F. D. Ott,* Burton's Bay near Wachapreague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: Mathieson and Fuller (1969), beach north of Cove Point, 1300 yards east of Red Nun #6 off Sharps Island Light, between Poplar Island Narrows Light and Can #1, 900 yards east of Coaches Island, mouth of Crab Alley Bay off Parson Island and Bodkin Island, east of Knapps Narrows, off Half Pone Point.

Family DELESSERICEAE Bory de Saint-Vincent orth. mut. Nageli

Caloglossa leprieurii (Montagne) J. Agardh: VIRGINIA: *F. D. Ott,* York River at Sandy Point on *Spartina* stems. Post (1968), James River on shore of Mulberry Island above Nells Creek, *R. Patrick;* James River at Cobham's Wharf, *J. C. Strickland.* MARYLAND: Post (1968), at east-

ern shore of mouth of St. Leonard Creek near Solomon's Island, *G. Papenfuss.*

Grinnellia americana (C. Agardh) Harvey: VIRGINIA: *H. J. Humm,* adrift at Norfolk end of bridge in Hampton Roads; *H. J. Humm,* York River at Gloucester Point; *J. Vogel* and *K. M. S. Aziz,* Haven Beach in Mathews County; *F. D. Ott,* Burton's Bay near Wachapreague. Zaneveld and Barnes (1965), lower Chesapeake Bay; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Ocean City in marsh area just south of jetty.

Family RHODOMELACEAE (J. Agardh) Harvey

Bostrychia radicans Montagne: VIRGINIA: *F. D. Ott,* James River at College Creek on old wooden retaining wall. Post (1968), James River on shore of Mulberry Island above Nells Creek, *R. Patrick* (as *Bostrychia rivularis*); on the sea wall ca. ¼ mile above the York River Bridge at Yorktown, *H. J. Humm;* James River at Cobham's Wharf, *J. C. Strickland;* Old Plantation Creek ca. two miles south of Cape Charles, *H. G. Richards.* MARYLAND: Post (1968), at eastern shore of mouth of St. Leonard Creek, near Solomon's Island, *G. Papenfuss* (as *Bostrychia radicans* forma *moniliforme*); at Patuxent River opposite Solomon's Island Bridge, *G. Papenfuss.*

Bostrychia rivularis Harvey: VIRGINIA: *H. J. Humm,* York River in the Guinea Marshes. Rhodes (1970), Burton's Bay near Wachapreague.

Chondria baileyana (Montagne) Harvey: VIRGINIA: *H. J. Humm,* York River in the Guinea Marshes; *F. D. Ott,* Burton's Bay near Wachapreague.

Chondria sedifolia Harvey: VIRGINIA: Rhodes (1970), Burton's Bay near Wachapreague.

Chondria tenuissima (Goodenough et Woodward) C. Agardh: VIRGINIA: *H. J. Humm,* jetty at Cape Charles. Zaneveld (1966-67); Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: Zaneveld (1966-67), *sine locus.*

Polysiphonia denudata (Dillwyn) Kützing: VIRGINIA: *P. E. Hargraves,* adrift in the York River at Gloucester

Point; *H. J. Humm,* York River at Gloucester Point; *D. Kapram,* York River at Gloucester Point; *F. D. Ott,* Chesapeake Bay at Cape Charles. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. L. Wulff, B. H. Robison* and *J. K. Lowry,* intertidal region at Ocean City; *J. K. Lowry, B. H. Robison* and *B. L. Wulff,* north jetty at Ocean City; *F. D. Ott,* Assateague Beach, abundant in the wash. Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Polysiphonia harveyi Bailey: VIRGINIA: *H. J. Humm,* Hummock Channel near Wachapreague; *M. Wass,* York River near Gloucester Point; *J. Vogel,* east side of Gwynn Island near mouth of Rappahannock River; *F. D. Ott,* Hampton Roads at Lynnhaven Inlet. Zaneveld and Barnes (1965), lower Chesapeake Bay; Zaneveld (1966-67); Mangum, Santos and Rhodes (1968), York River at Sandy Point; Mathieson and Fuller (1969), Mobjack Bay off Guinea Marsh; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City; Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City; Mathieson and Fuller (1969), rock retaining wall on Naval Base property on south shore of Patuxent River, abandoned Cedar Point Light House, beach north of Cove Point, Holland Strait off South Marsh Island, mid-channel in Broad Creek connecting Little Annemessex River and Pocomoke Sound, Shark Fin Shoal east of Bloodsworth Island, 1.5 miles east of Bloodsworth Island, between Poplar Island Narrows Light and Can #1, 900 yards east of Coaches Island, mouth of Crab Alley Bay off Parson Island and Bodkin Island, channel between James Island and Red Nun #2, east and west of Knapps Narrows, Kent Narrows and pilings at Piney Narrows Marina.

Polysiphonia nigrescens (Hudson) Greville: VIRGINIA: *B. L. Wulff,* York River at Gloucester Point; *F. D. Ott,* Burton's Bay near Wachapreague. Zaneveld and Barnes

(1965), lower Chesapeake Bay; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point; Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: *F. D. Ott,* Ocean City on stones of jetty. Zaneveld (1966-67).

Polysiphonia novae-angliae Taylor: MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City; *J. K. Lowry, B. L. Wulff* and *B. H. Robison,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Polysiphonia subtilissima Montagne: VIRGINIA: *J. Vogel,* west side of Gwynn Island near mouth of the Rappahannock River; *F. D. Ott,* Chesapeake Bay at Cape Charles. Zaneveld (1966-67); Marsh (1970), York River; Rhodes (1970), Burton's Bay near Wachapreague. MARYLAND: Zaneveld (1966-67).

Polysiphonia urceolata (Lightfoot) Greville: MARYLAND: *J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

DIVISION CYANOPHYCOPHYTA

Family CHROOCOCCACEAE Nägeli

Agmenellum quadruplicatum (Meneghini) de Brébisson: GENERAL: Griffith (1961), Chesapeake Bay, *R. E. Griffith; D. C. Morris.*

Agmenellum thermale (Kützing) Drouet et Daily: MARYLAND: Drouet and Daily (1956), Potomac River at Plummers Island west of Cabin John, *F. Drouet, E. P. Killip* and *D. Richards.*

Anacystis cyanea Drouet et Daily: VIRGINIA: *B. L. Wulff* bloom in the Rappahannock between Tappahannock and Port Royal. Drouet and Daily (1956), Queens Creek at Haw Tree Landing, *A. F. Chestnut.*

Anacystis dimidiata (Kützing) Drouet et Daily: VIRGINIA: Zaneveld (1966), Chincoteague Island in a ditch, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland.* MARY-

LAND: Zaneveld (1966), Smith Island at Tylerton, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Anacystis marina Drouet et Daily: VIRGINIA: *E. T.* and *B. L. Wulff,* York River at Gloucester Point; *H. J. Humm,* York River at Gloucester Point. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Anacystis montana (Lightfoot) Drouet et Daily forma *montana* (Lightfoot) Drouet et Daily: GENERAL: Griffith (1961), Chesapeake Bay.

Anacystis montana (Lightfoot) Drouet et Daily forma *minor* (Wille) Drouet et Daily: GENERAL: Griffith (1961), Chesapeake Bay.

Anacystis thermalis (Meneghini) Drouet et Daily forma *thermalis* (Meneghini) Drouet et Daily: GENERAL: Griffith (1961), Chesapeake Bay.

Chroococcus turgidus (Kützing) Nägeli: MARYLAND: Drouet (1939), in brackish waters: marsh pool at Chance, marsh pool west of Ewell on Smiths Island, marsh pool at Tylerton on Smiths Island, *P. W. Wolle.*

Chroococcus sp.: MARYLAND: Morse (1947), mouth of Patuxent River.

Coccochloris elabens (de Brébisson) Drouet et Daily: GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Coccochloris peniocystis (Kützing) Drouet et Daily: GENERAL: Griffith (1961), Chesapeake Bay.

Coccochloris stagnina Sprengel: VIRGINIA: Drouet and Daily (1956), Virginia Beach in pool and on wet soil in the Back Bay National Wildlife Refuge, *H. A. Bailey, E. S. Luttrell* and *J. C. Strickland;* Zaneveld (1966), Virginia Beach in the Back Bay National Wildlife Refuge in pool and on wet soil under slightly brackish conditions, *H. A. Bailey, E. S. Luttrell* and *J. C. Strickland.* MARYLAND: Zaneveld (1966). GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Gomphosphaeria aponina Kützing: MARYLAND: Drouet (1939), in brackish water: marsh pool between Chance

and Dames Quarter. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Gomphosphaeria lacustris Chodat: GENERAL: Griffith (1961), Chesapeake Bay.

Johannesbaptistia pellucida (Dickie) Taylor et Drouet: MARYLAND: Drouet (1939), brackish waters: marsh pool west of Ewell on Smiths Island, marsh pool between Chance and Dames Quarter, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Merismopedia glauca (Ehrenburg) Nägeli: MARYLAND: Morse (1947), mouth of Patuxent River.

Family ENTOPHYSALIDACEAE Geitler

Entophysalis conferta Drouet et Daily: VIRGINIA: *M. Wass,* York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River at Sandy Point. MARYLAND: Wulff *et al* (1968), jetty at Ocean City.

Entophysalis deusta (Meneghini) Drouet et Daily: VIRGINIA: Drouet and Daily (1956), York River at Yorktown, *J. C. Strickland,* York River at Yorktown, *H. J. Humm;* Zaneveld (1966), York River at Yorktown, *J. C. Strickland,* Zaneveld (1966); Wulff (1967), York River at Gloucester Point; Mangum, Santos and Rhodes (1968), York River at Sandy Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City. Drouet and Daily (1956), salt marsh flat at Chesapeake Beach, *E. C. Leonard,* in Patuxent River at Solomons Island, *F. Drouet, E. P. Killip* and *F. R. Forsberg,* on mud at Wenona, *P. W. Wolle* and *F. Drouet,* on hardened soil on the shore of Tangier Sound near Prickly Point, *F. Drouet* and *P. W. Wolle;* Zaneveld (1966). Wulff *et al* (1968), jetty at Ocean City. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Family OSCILLATORIACEAE (S. F. Gray) Dumortier ex Kirchner

Arthrospira brevis (Kützing) Drouet: VIRGINIA: Drouet (1968), culture from York River at Yorktown, *J. C. Strickland.* MARYLAND: Drouet (1968), on mud and pilings at

Wenona, *P. W. Wolle* and *F. Drouet;* bank of Potomac River above Point of Rocks, *M. H. Hohn.*

Hydrocoleum holdenii Tilden: MARYLAND: Drouet (1939), in a salt marsh one mile south of Public Landing in Assateague Bay, *P. W. Wolle;* marsh ditch at Tylerton on Smiths Island, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet* and *F. K. Daily.*

Lyngbya aerugineo-coerulea (Kützing) Gomont: GENERAL: Griffith (1961), Chesapeake Bay.

Lyngbya aestuarii (Mertens) Lyngbye in Liebman ex Gomont: VIRGINIA: Strickland (1940), from a marine aquarium at West Point, *J. W. Bailey* and *J. C. Strickland;* Zaneveld (1966), Chincoteague Island, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland;* coating on dead tree five miles upstream from the York River Bridge, at the old ferry landing at Gloucester Point, on border of York River near Gloucester Point, *C. F. Rhyne;* Zaneveld (1966-67). MARYLAND: Drouet (1939), subaerial in brackish and marine waters: salt marsh at Public Landing in Assateague Bay, *P. W. Wolle,* brackish ditch at Ewell; Zaneveld (1966), Rattlesnake Landing at Chincoteague Bay, *J. Zaneveld, W. D. Barnes* and *H. W. West;* Zaneveld (1966-67). GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Lyngbya confervoides C. Agardh ex Gomont: VIRGINIA: Zaneveld (1966). MARYLAND: Drouet (1939), on rocks and wood in marine waters: on pilings of old wharf at Public Landing in Assateague Bay, *P. W. Wolle,* jetty on Upper Thoroughfare on Deal Island, on rocks at Wenona; Zaneveld (1966), Ocean City in harbor on wooden pilings, *J. Zaneveld, W. D. Barnes* and *H. W. West;* Zaneveld (1966). GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Lyngbya gracilis (Meneghini) Rabenhorst: VIRGINIA: *H. J. Humm,* York River in the Guinea Marshes.

Lyngbya lutea (C. Agardh) Gomont ex Gomont: VIRGINIA: Strickland (1940), in brackish and salt water habitats: from pilings of West Norfolk Bridge in Portsmouth, on stump in James River at Cobham's Wharf; Zaneveld

(1966), on pilings of West Norfolk Bridge in Portsmouth, *J. C. Strickland,* on stump in James River at Cobham's Wharf, *J. C. Strickland;* York River at Seaford, *R. W. Menzel* and *J. C. Strickland.* MARYLAND: Drouet (1939), on rocks and wet soil on shores: on banks of Nanticoke River opposite Sand Hill Beach at Tyaskin. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Lyngbya semiplena (C. Agardh) J. Agardh ex Gomont: VIRGINIA: Zaneveld (1966), Chincoteague Island, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland,* Wachapreague in harbor on wooden pilings, *J. Zaneveld, W. D. Barnes* and *H. W. West,* Cape Charles city harbor on rocks of breakwater, *C. F. Rhyne,* Virginia Beach at Lynnhaven Inlet, *W. D. Barnes,* Virginia Beach at Lynnhaven Inlet forming a slimy coating on a bulkhead, *W. D. Barnes,* western side of Lynnhaven Bay on oyster shells, *W. D. Barnes,* Little Creek Inlet on the western breakwater, *C. F. Rhyne, B. Phillips* and *J. Zaneveld,* Back Bay, *H. A. Bailey, E. S. Luttrell* and *J. C. Strickland,* Chesapeake at west side of Great Bridge, *C. M. Wilson,* Norfolk on rocks, *W. D. Barnes* and *H. W. West,* in York River at Queens Creek, *A. F. Chestnut* and *J. C. Strickland,* York River five miles upstream from York River Bridge, along border of York River, *C. F. Rhyne.* MARYLAND: *J. K. Lowry, B. H. Robison* and *B. L. Wulff,* north jetty at Ocean City. Drouet (1939), in marine and brackish waters: in Chesapeake Bay, *H. C. Bold;* Zaneveld (1966); Wulff *et al* (1968), jetty at Ocean City. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Microcoleus chthonoplastes (Mertens) Zanardini ex Gomont: VIRGINIA: *K. M. S. Aziz,* Mobjack Bay; Zaneveld (1966), at the old ferry landing at Gloucester Point, on border of York River near Gloucester Point, *C. F. Rhyne;* Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: Drouet (1939), on mud flat between Ewell and Rhodes Point on Smiths Island, brackish ditch between Wenona and Deal Island, wet sand along Upper

Thoroughfare on Deal Island, on wet soil at White Haven Ferry at Mt. Vernon; Zaneveld (1966), Rattlesnake Landing in Chincoteague Bay, *J. Zaneveld, W. D Barnes,* and *H. W. West;* Zaneveld (1966-67). GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Microcoleus lyngbyaceus (Kützing) Crouan: VIRGINIA: Wulff (1967), York River at Gloucester Point; Drouet (1968), Mulberry Island in James River, *R. Patrick;* Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: Drouet (1968), Crisfield, *F. Drouet* and *P. W. Wolle;* Cabin John, *F. Drouet* and *E. P. Killip,* Chesapeake Bay, *H. C. Bold,* Chincoteague Bay, *J. Zaneveld, W. D. Barnes* and *H. W. West.*

Microcoleus tenerrimus Gomont: VIRGINIA: *K. M. S. Aziz,* York River between York River Bridge and Naval Weapons Station; Zaneveld (1966), western side of Lynnhaven Inlet on oyster shells, *W. D. Barnes* and *H. W. West.* MARYLAND: Drouet (1939), in brackish and marine waters: on pilings at Wenona. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Microcoleus vaginatus (Vaucher) Gomont: VIRGINIA: Drouet (1968), James River downstream from Jamestown, *R. Patrick.* MARYLAND: Drouet (1968), Patuxent River at Benedict, *F. Drouet* and *C. W. Reimer,* Plummers Island in Potomac River west of Cabin John, *Drouet et al.*

Oscillatoria amphibia C. Agardh ex Gomont: VIRGINIA: Zaneveld (1966), west of Queen Sound, *L. C. Goldstein, E. S. Luttrell,* and *J. C. Strickland.* MARYLAND: Drouet (1939), in brackish and almost fresh water: marsh pool between Chance and Dames Quarter; Zaneveld (1966). GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Oscillatoria brevis Kützing ex Gomont var. *neapolitana* (Kützing) Gomont: MARYLAND: Drouet (1939), in brackish and semi-marine waters, on pilings at Wenona, puddle at old wharf at Shelltown, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Oscillatoria laetevirens Crouan ex Gomont: VIRGINIA:

Zaneveld (1966), York River at Seaford, *J. C. Strickland*; Zaneveld (1966-67).

Oscillatoria lutea C. Agardh: VIRGINIA: Drouet (1968). on pilings at Seaford, *J. C. Strickland*, on shells in James River 4.5 miles downstream from Jamestown Island, *R. Patrick*, pilings of bridge at Portsmouth, *J. C. Strickland et al.* MARYLAND: Drouet (1968), bank of Nanticoke River opposite Sandy Hill Beach at Tyaskin, *P. W. Wolle* and *F. Drouet*.

Oscillatoria margaritifera Kützing ex Gomont: VIRGINIA: Zaneveld (1966), west of Queens Sound, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland*, York River at Seaford, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland*. MARYLAND: Drouet (1939), in brackish and semimarine waters: marsh ditch at Weona, *P. W. Wolle*, marsh pool at Chance. marsh ditch at Tylerton on Smiths Island, *P. W. Wolle*; Zaneveld (1966).

Oscillatoria nigro-viridis Thwaites in Harvey ex Gomont: VIRGINIA: *B. L. Wulff*, York River at Gloucester Point. Strickland (1940), on pilings of the West Norfolk Bridge at Portsmouth; Zaneveld (1966), west of Queen Sound, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland*, on pilings of West Norfolk bridge, *J. C. Strickland*. MARYLAND: Drouet (1939), in marine and semimarine waters: on pilings at Wenona.

Oscillatoria princeps Vaucher ex Gomont: VIRGINIA: Zaneveld (1966), northwest of Wachapreague, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland*, Portsmouth west of Hickory, *C. M. Wilson*. MARYLAND: Zaneveld (1966).

Oscillatoria retzii C. Agardh: VIRGINIA: Drouet (1968). on logs in James River north of the Fort Eustis Dock. *R. Patrick*.

Oscillatoria salinarum Collins, Holden and Setchell: VIRGINIA: Zaneveld (1966), west of Queen Sound, *L. C. Goldstein, E. S. Luttrell* and *J. C. Strickland*. MARYLAND: Drouet (1939), brackish ditch at Ewell on Smiths Island. marsh ditch near Wenona, *P. W. Wolle*, Tylerton, *P. W. Wolle*.

Oscillatoria splendida Greville ex Gomont: VIRGINIA: Zaneveld (1966), Portsmouth west of Great Bridge, *C. M. Wilson;* Zaneveld (1966-67). MARYLAND: Zaneveld (1966).

Oscillatoria submembranaceae Ardissone et Strafforello: VIRGINIA: Drouet (1968), on barnacles on a pier at Seaford, *J. C. Strickland.* MARYLAND: Drouet (1968), on mud at Ewell on Smiths Island, *P. W. Wolle* and *F. Drouet,* on an alluvial flat on Plummers Island in the Potomac River west of Cabin John.

Oscillatoria subuliformis Thwaites in Kützing ex Gomont: VIRGINIA: *M. Wass,* on barnacles on a buoy in Sarah's Creek. Strickland (1940), from experimental jars in which oysters were active at West Point, *J. W. Bailey,* in Richmond from a marine aquarium at the University of Virginia, *J. W. Bailey* and *J. C. Strickland.* Zaneveld (1966), Yorktown, *R. M. Moore* and *J. C. Strickland,* south border of York River.

Oscillatoria sp.: VIRGINIA: Marshall (1967), Elizabeth River. MARYLAND: Morse (1947), mouth of Patuxent River.

Phormidium persicinum (Reinke) Gomont: VIRGINIA: Strickland (1940), from marine aquaria at West Point, *J. W. Bailey* and *J. C. Strickland.*

Phormidium retzii (C. Agardh) Kützing ex Gomont: VIRGINIA: Strickland (1940), James River at Cobham's Wharf.

Phormidium submembranaceum (Ardissone et Strafforello) Gomont: VIRGINIA: *H. J. Humm,* York River at Gloucester Point.

Phormidium uncinatum (J. Agardh) Gomont: VIRGINIA: *M. Wass,* York River at Gloucester Point.

Phormidium weissi Drouet: MARYLAND: Drouet (1939), in a brackish pool at Wenona, on *Ruppia* in a marsh pool between Ewell and Rhodes Point on Smiths Island, road puddle at old wharf at Shelltown, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Porphyrosiphon notarisii (Meneghini) Kützing: VIRGINIA: Wulff (1967), York River at Gloucester Point;

Drouet (1968), Mulberry Island in the James River; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: Drouet (1968), in a saltmarsh near Jenkins Creek at Crisfield, *F. Drouet* and *P. W. Wolle.*

Porphyrosiphon splendidus (Greville) Drouet: VIRGINIA: Drouet (1968), Portsmouth west of Great Bridge, *C. M. Wilson.* MARYLAND: Drouet (1968), Potomac River three miles below mouth of Monocacy River, *M. H. Hohn,* Waterloo Marsh at Monie Creek, *P. W. Wolle.*

Schizothrix arenaria (Berkeley) Gomont: VIRGINIA: Drouet (1968), James River north of Fort Eustis Dock, *R. Patrick.* MARYLAND: Drouet (1968), Plummers Island in Potomac River west of Cabin John, *F. Drouet* and *E. P. Killip,* marsh on shore of Patuxent River, *F. Drouet* and *C. W. Reimer,* salt marsh near Rattlesnake Landing at Chincoteague Bay, *Moul.*

Schizothrix calcicola (C. Agardh) Gomont: VIRGINIA: *E. T.* and *B. L. Wulff,* York River at Gloucester Point; *H. J. Humm,* York River at Gloucester Point. Zaneveld (1966), Strickland in MS 1943; Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Drouet (1968), James River at Mulberry Island, *R. Patrick,* York River at West Point, *J. W. Bailey,* in James River downstream from Jamestown Island; Mangum, Santos and Rhodes (1968), York River at Sandy Point; Wulff and Webb (1968), York River at Gloucester Point. MARYLAND: Drouet (1968), in Potomac River west of Cabin John, *F. Drouet* and *E. P. Killip,* salt marsh at Crisfield, *F. Drouet* and *P. W. Wolle,* in Patuxent River at Solomons Island, *E. P. Killip, F. Drouet* and *F. R. Fosberg;* Wulff *et al* (1968), jetty at Ocean City.

Schizothrix tenerrima (Gomont) Drouet: VIRGINIA: Drouet (1968), James River at Mulberry Island, *R. Patrick,* James River at Cobham's Wharf, *J. C. Strickland.* MARYLAND: Drouet (1968), Patuxent River at Solomons Island, *F. Drouet, E. P. Killip* and *F. R. Fosberg,* at Wenona, *P. W. Wolle* and *F. Drouet.*

Spirulina major Kützing ex Gomont: MARYLAND: Drouet

(1939), brackish pool at Wenona, Cove Point, *H. C. Bold.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Spirulina subsalsa Oersted ex Gomont: VIRGINIA: Strickland (1940), York River near West Point, *J. W. Bailey,* at West Point from jars in which oysters were active, *J. W. Bailey,* in Richmond at the University of Richmond in a marine aquarium; Zaneveld (1966), York River near Yorktown, *J. C. Strickland;* Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: Drouet (1939), in marine and brackish waters: in a marsh pool between Chance and Dames Quarter; Zaneveld (1966); Drouet (1968), Cove Point, *H. C. Bold,* Jerico Marshes west of Fairmount, *F. Drouet* and *P. W. Wolle,* between Ewell and Rhodes Point on Smiths Island, *P. W. Wolle* and *F. Drouet,* marsh south of Jenkins Creek near Crisfield, *F. Drouet* and *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Spirulina subsalsa Oersted forma *oceanica* (Crouan) Gomont: VIRGINIA: *H. J. Humm,* on barnacles from a buoy in Sarah's Creek.

Spirulina tenerrima Kützing ex Gomont: MARYLAND: Drouet (1939), in brackish and marine waters: marsh pool between Ewell and Rhodes Point on Smiths Island. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Spirulina sp.: MARYLAND: Morse (1947), mouth of Patuxent River.

Symploca atlantica Gomont: VIRGINIA: Strickland (1940), James River at Cobham's Wharf; Zaneveld (1966), York River near Gloucester Point, *C. F. Rhyne,* James River at Cobham's Wharf, *J. C. Strickland.* MARYLAND: Zaneveld (1966), on wooden harbor pilings at Snow Hill Public Landing, *J. Zaneveld, W. D. Barnes,* and *H. W. West.*

Trichodesmium thiebautii Gomont: VIRGINIA: *F. D. Ott,* very abundant in the phytoplankton during August and September in the lower Chesapeake Bay, 1970.

Family NOSTOCACEAE Dumortier ex Engler

Anabaena inaequalis (Kützing) Bornet et Flahault: VIRGINIA: *H. J. Humm,* York River at Yorktown.

Anabaena sphaerica Bornet et Flahault: MARYLAND: Drouet (1939), in a brackish ditch between Wenona and Deal Island. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Anabaena torulosa (Carmichael) Lagerheim ex Bornet et Flahault: VIRGINIA: Zaneveld (1966), south border of York River near the York River Bridge.

Family MICROCHAETACEAE Lemmermann

Nodularia harveyana (Thwaites) Thuret: VIRGINIA: *K. M. S. Aziz,* York River at Yorktown. MARYLAND: Drouet (1939), floating in a brackish pond at Rhodes Point on Smiths Island. GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Family RIVULARIACEAE Kützing ex Bornet et Flahault

Dichothrix penicillata Zanardini ex Bornet et Flahault: VIRGINIA: Zaneveld (1966), York River 15 miles downstream from the York River Bridge.

Calothrix confervicola (Roth) C. Agardh: VIRGINIA: *K. M. S. Aziz,* York River between the York River Bridge and the Naval Weapons Station. MARYLAND: *B. L. Wulff, B. H. Robison* and *J. K. Lowry,* north jetty at Ocean City, *J. K. Lowry, B. H. Robison* and *B. L. Wulff,* north jetty at Ocean City. Wulff *et al* (1968), jetty at Ocean City.

Calothrix crustaceae Schousboe et Thuret ex Bornet et Thuret: VIRGINIA: *H. J. Humm,* York River at Gloucester Point. Zaneveld (1966), on oyster shells on the west side of Lynnhaven Inlet, *W. D. Barnes* and *H. W. West,* on wooden pole of the old ferry landing at Gloucester Point, *J. Zaneveld;* Zaneveld (1966-67); Wulff (1967), York River at Gloucester Point; Wulff and Webb (1969), York River at Gloucester Point. MARYLAND: *B. H. Robison, J. K. Lowry* and *B. L. Wulff,* north jetty at Ocean City; *J. K. Lowry, B. H. Robison* and *B. L. Wulff,* north jetty at Ocean City. Zaneveld (1966), Snow Hill Public Landing on concrete blocks in Chincoteague Bay, *J. Zaneveld, W. D.*

Barnes and *H. W. West;* Zaneveld (1966-67); Wulff *et al* (1968), jetty at Ocean City.

Calothrix pulvinata (Mertens) C. Agardh: MARYLAND: Drouet (1939), in marine and brackish waters: on pilings in Nanticoke River at Sandy Hill Beach in Tyaskin, on pilings of old wharf at Shelltown, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Rivularia nitida C. Agardh: MARYLAND: Drouet (1939), in wet brackish places: on cedar stumps at head of Pocomoke Sound below Shelltown, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Family SCYTONEMATACEAE Kützing ex Bornet et Flahault

Fremyella grisea (Bornet et Flahault) J. de Toni: MARYLAND: Drouet (1939), in marine and brackish waters: on pilings of old wharf at Shelltown, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Plectonema calothrichoides Gomont: VIRGINIA: *K. M. S. Aziz,* York River above the York River Bridge.

Plectonema golenkinianum Gomont: MARYLAND: Drouet (1939), in marine and brackish waters: on pilings of old wharf at Shelltown, *P. W. Wolle.* GENERAL: Griffith (1961), Chesapeake Bay, *F. Drouet.*

Plectonema terebrans Bornet et Flahault: VIRGINIA: *K. M. S. Aziz,* York River near Yorktown.

Family STIGONEMATACEAE Kirchner

Mastigocoleus testarum Bornet et Flahault: VIRGINIA: *H. J. Humm,* York River at Gloucester Point.

SUMMARY

In the preceding treatment 213 taxa have been recorded for the area under study. A number of these taxa, especially in the Chlorophycophyta, are strictly freshwater algae and are included herein only because they have been reported as being present. A few other taxa of the Cyanophycophyta may be entered in this treatment under two different names for the reasons discussed in the introduction to this paper.

These 213 taxa are distributed in the four algal divisions as follows:

Division	*Number*	*Percent*
Chlorophycophyta	55	25.8
Phaeophycophyta	29	13.6
Rhodophycophyta	54	25.4
Cyanophycophyta	75	35.2

It is interesting to note that the majority of the collecting sites within the area under study center about either 1) the marine laboratories located at Solomons Island, Gloucester Point, Norfolk, and Wachapreague, or, 2) the stone jetties at Ocean City and in Norfolk. Little attention has been given to the algal flora elsewhere including the thousands of acres of *Spartina* salt marshes, the oyster reefs, and the possible algal flora of the deeper waters off the Atlantic coast and in the Chesapeake Bay. As these particular areas are more thoroughly and more systematically surveyed, it should be anticipated that additional taxa will be added to the marine algal flora of Maryland and Virginia. For each algal species reported, its known geographical distribution in the area is given.

ACKNOWLEDGMENTS

I acknowledge with pleasure the use of the Virginia Institute of Marine Science herbarium. I am appreciative to Dr. Russell Rhodes and Dr. Marvin Wass for referring me to pertinent papers in the periodical literature which were unknown to me. Lastly, I express my sincere thanks to Dr. Marvin Wass and to my wife, Dr. Aleta Petrik-Ott, who proofread this paper.

LITERATURE CITED

BOLD, H. C. 1967. *Morphology of Plants*, 2nd ed. Harper & Row, Publishers, New York. XXIX + 541 pp.

DROUET, F. 1939. The Myxophyceae of Maryland. *Field Mus. Nat. Hist., Bot. Ser.* (Chicago) **20**(1): 1-14.

———. 1968. *Revision of the Classification of the Oscillatoriaceae.* Monograph No. 15, The Academy of Natural Sciences of Philadelphia. Philadelphia. 370 pp., including 131 figs.

DROUET, F. and W. A. DAILY. 1956. Revision of the Cocoid Myxophyceae. *Butler Univ. Bot. Studies* (Indianapolis) XII: 1-218.

GRIFFITH, R. E. 1961. *Phytoplankton of Chesapeake Bay, an Illustrated Guide to the Genera.* Contribution No. 172, Cheasapeake Biological Laboratory, Maryland Department of Research and Education, Solomons, Maryland. IV + 79 pp., including 123 figs.

HUMM, H. J. 1963. *Dictyota dichotoma* in Virginia. *Virginia Jour. Sci.* (Richmond) (N.S.) **14**(3): 109-111.

MANGUM, C. P., S. L. SANTOS, and W. R. RHODES, JR. 1968. Distribution and feeding in the onuphid polychaete, *Diopatra cuprea* (Bosc.) *Mar. Biol.* (Berlin) **2**: 33-40.

MARSH, G. A. 1970. *A Seasonal Study of* Zostera *Epibiota in the York River, Virginia.* Doctor of Philosophy Dissertation, College of William and Mary, Faculty of the School of Marine Science, Gloucester Point, Virginia. XI + 156 pp.

MARSHALL, H. G. 1967. Plankton in James River Estuary, Virginia II. Phytoplankton in the Elizabeth River. *Virginia Jour. Sci.* (Richmond) (*N.S.*) **18**(3): 105-109.

MATHIESON, A. and S. W. FULLER. 1969. A preliminary investigation of the benthonic marine algae of Chesapeake Bay region. *Rhodora* (Boston) **71**: 524-534.

MORSE, D. C. 1947. Some observations on seasonal variations in plankton population, Patuxent River, Maryland, 1943-1945. *Chesapeake Biol. Lab. Publ.* (Solomons, Maryland) **65**: 1-31.

PAPENFUSS, G. F. 1955. Classification of the Algae, pp. 115-224 *in* R. C. Miller, E. L. Kessel and G. F. Papenfuss. *A. Century of Progress in the Natural Sciences, 1853-1953.* California Academy of Science, San Francisco. XII + 807 pp.

PATTEN, B. C., R. A. MULFORD and J. E. WARINNER. 1963. An annual phytoplankton cycle in the lower Chesapeake Bay. *Chesapeake Sci.* (Solomons, Maryland) **4**(1): 1-20.

POST, E. 1968. Zur Verbreitungs-Ökologie des Bostrychietum. *Hydrobiologia* (Den Haag) **31**(2): 241-316.

RHODES, R. G. 1970. Seasonal occurrence of marine algae on an oyster reef in Burton's Bay, Virginia. *Chesapeake Sci.* (Solomons, Maryland) **11**(1): 61-63.

STRICKLAND, J. C. 1940. The Oscillatoriaceae of Virginia. *Amer. Jour. Bot.* (Lancaster) **27**: 628-633.

WOODSON, B. E. 1959. A study of the Chlorophyta of the James River basin, Virginia. I. Collection points and species list. *Virginia Jour. Sci.* (Richmond) (N.S.) **10**(2): 70-82.

WULFF, B. L. 1967. *Intertidal Zonation of Marine Algae at Gloucester Point, Virginia.* Master of Arts Thesis, The College of William and Mary, Department of Marine Science, The Virginia Institute of Marine Science, Gloucester Point, Virginia. VII + 49 pp.

WULFF, B. L., E. M. T. WULFF, B. H. ROBISON, J. K. LOWRY, and H. J. HUMM. 1968. Summer marine algae of the jetty at Ocean City, Maryland. *Chesapeake Sci.* (Solomons, Maryland) **9**(1): 56-60.

WULFF, B. L. and K. L. WEBB. 1969. Intertidal zonation of marine algae at Gloucester Point, Virginia. *Chesapeake Sci.* (Solomons, Maryland) **10**(1): 29-35.

ZANEVELD, J. 1966. The marine algae of the American coast between Cape May, N. J. and Cape Hatteras, N. C. I. The Cyanophyta. *Bot. Mar.* (*Hamburg*) IX(¾): 101-128, including figs. 1-7.

ZANEVELD, J. S. and W. D. BARNES. 1965. Reproductive periodicities of some benthic algae in lower Chesapeake Bay. *Chesapeake Sci.* (Solomons, Maryland) **6**(1): 17-32.

ZANEVELD, J. S. 1966-67. *The Benthic Marine Algae of Delaware: A Preliminary Checklist, Revised from 1966.* Scientific Series, Publication No. 2, Old Dominion College, Norfolk, Virginia. 36 pp. mimeographed.

VIRGINIA INSTITUTE OF MARINE SCIENCE
GLOUCESTER POINT, VIRGINIA 23062

THE PRINGLE HERBARIUM

FRANK C. SEYMOUR

In the Pringle Herbarium of the University of Vermont are 335,000 specimens of plants ranging all the way from Fungi and Algae to Orchids and Compositae. While Vermont is the area by far the best represented, the specimens come from many far-scattered and remote parts of the earth. Between 5,000 and 6,000 specimens are being added each year. We believe that few botanists realize what extensive resources are available in this Herbarium for research and study. Visiting botanists have exclaimed repeatedly over the wealth of material which they have found here. "I had no idea that you had so many significant specimens," one commented. Or, "If we had only known you had such rare numbers, we should have come sooner." "I supposed this specimen was not to be seen nearer than Europe," another added. When there are such choice specimens in this herbarium, to make these resources known to the scientific world becomes almost a duty.

What proportion of our 337,000 specimens come from our own state is difficult to estimate. In view of the many sheets from other parts of the world, it cannot be large, — pehaps 1 in 10 from the state of Vermont. A County List, now being prepared by the Vermont Botanical and Bird Club, will, when published, show how wide a representation is from Vermont. That County List will include various herbaria, with symbols to indicate in which herbaria voucher specimens are to be found.

Among collectors of Vermont plants, Cyrus Guernsey Pringle still leads the list. Beginning his collecting in 1876, Vermont, especially his home town of Charlotte, was naturally the scene of his earliest as well as his latest endeavors. By his own labor and initiative, he built up the herbarium to 150,000 sheets. While the majority of these are from Mexico, he made extensive collections from his own state.

Mrs. Nellie F. Flynn assembled a massive herbarium, mostly by her own collecting, largely from the region of Burlington. Her entire herbarium is deposited with the Pringle Herbarium as a permanent loan.

Ezra Brainerd, at one time President of Middlebury College, is best known for his published studies of Violets and Blackberries. Also in the genus *Crataegus* (Hawthorns), he collected great quantities of specimens. His entire herbarium is now in the Pringle Herbarium.

Dana S. Carpenter built up a large herbarium of notable importance, mostly from Vermont, but including also much material from distant lands. D. Lewis Dutton accomplished a similar work with specimens mostly from Vermont. Both of their herbaria are now parts of the Pringle Herbarium.

A. J. Grout, most famous for his work with mosses, is another of the early collectors, thousands of whose specimens add greatly to our knowledge of the flora of Vermont.

Among others who have contributed notably to this herbarium and to our knowledge of Vermont plants, the following botanists should be mentioned. L. R. Jones, at one time Curator of this Herbarium, added many significant specimens. Sidney F. Blake, known throughout the world as an authority on the family, Compositae, contributed many specimens especially from the northwestern part of Vermont. George L. Kirk, by profession a journalist, by his keen observation added extensively to the known flora of the state. The late Leopold A. Charette contributed greatly to the knowledge of distribution records in Vermont and would have done much more if an untimely death had not cut short his botanical career. His earlier herbarium containing a large collection of plants of Japan as well as of Vermont was purchased by the Pringle Herbarium. The herbarium of Ernest L. Smith, with many choice plants of Vermont, was a gift of his daughter, Marion L. Smith.

From the other New England states, there are substantial numbers of specimens, with Maine probably leading. M. L. Fernald, John J. Cushman and Frank C. Seymour

are among the collectors there. J. W. Congdon's plants from Rhode Island include some items which probably are no longer to be found growing in that populous state. In Connecticut, collections by Arthur E. Blewitt, E. H. Eames and D. C. Eaton are notable. From Massachusetts, we have many specimens of F. F. Forbes and some of Thomas Morong, distinguished for his studies in aquatics. Mrs. Nellie F. Flynn's collections from Nantucket are remarkable not only for their quantity but for their variety. Among the large number of species are some which apparently have not been found there by any other botanist. Many specimens from New Hampshire were collected by A. S. Pease, author of "The Flora of Northern New Hampshire."

Nearly every one of the fifty states in the United States is amply represented. Among the outstanding collectors are the following: New York, *A. J. Grout;* New Jersey, *Levi J. Miller* "Halsted' American Weeds"; Pennsylvania, *J. K. Small, A. A. Heller;* North Carolina, *A. H. Curtiss;* Florida, *A. H. Curtiss, Nellie F. Flynn;* Michigan, *Frank C. Gates;* Alabama, *G. R. Vasey* and *"Ex herb.* C. Mohr, Mobile, Ala.," *F. S. Earle, C. F. Baker;* Gulf States, *S. M. Tracy;* Minnesota, *J. M. Holzinger, G. B. Ownbey;* Wisconsin, *T. G. Hartley; Illinois, C. G. Pringle;* Iowa, *Jack L. Carter;* Missouri, *B. F. Bush, N. C. Henderson;* Louisiana, *Nellie F. Flynn;* Texas, *J. Reverchon, N. C. Henderson;* Wyoming, *Aven Nelson;* Colorado, *George W. Letterman, C. F. Baker, H. N. Patterson, C. C. Parry;* Utah, *Marcus E. Jones, S. L. Welch, G. Moore;* Nevada, *C. F Baker;* Arizona, *C. G. Pringle, Elinor Lehto;* California, *C. G. Pringle, Joseph P. Tracy, Lewis S. Rose, A. D. E. Elmer, S. B.* and *W. F. Parish;* Washington, *C. V. Piper, W. N. Suksdorf, A. D. E. Elmer;* Pacific Coast, *Thomas J. Howell.*

Many of the collectors are pioneers in their areas, so that their specimens are of special value, and often cited in literature. From Alaska, we have many specimens of William Chadsworth. Cynthia J. Bigelow has made us a

gift of her summer's collection from the Yukon. Greenland's flora, most nearly related to North America, is represented by several hundred specimens distributed by the University of Copenhagen.

Turning to areas south of the United States, from Mexico we have the very extensive collections of Pringle, himself, whom Asa Gray called "the Prince of Plant Collectors." While his specimens have been distributed far and wide to many other herbaria, it is not certain that all numbers were so distributed. We probably have many which are not to be found in any other herbarium. Since his time, our Mexican material has been augmented by specimens from other collectors such as Edward Palmer, E. Matuda, C. Conzatti, Forrest M. Shreve, D. E. Breedlove, Harde LeSueur, Elwood Molseed, Stephen S. White, and C. L. Smith.

From Central America there are specimens collected by the following: Guatemala, *H. von Türckheim* and *Charles C. Deam;* British Honduras, *P. H. Gentle;* Honduras, *C. Thieme;* Costa Rica, *C. W. Dodge, W. S. Thomas, Austin Smith;* Panama, *M. E. Davidson, S. Hayes, H. von Wedel, P. H. Allen, R. E. Woodson, Jr., R. W. Schery.*

As a result of recent expeditions to Nicaragua, the 500 sheets already mounted from the largest country of Central America are only a small part of those soon to be added from the large collections distributed by Frank C. Seymour. While many numbers are being distributed to other herbaria, the unicates are being deposited in this herbarium.

From the West Indies, our largest collections are those from Guadeloupe by Pere Duss and others labeled "Herbier Capitaine." Cuba is one of the many areas from which Pringle has provided us with much material. To his have been added specimens of A. H. Curtiss.

South America is represented by important series from certain areas, such as the following: Brazil, Ex Museo Botanico Berolinensi, *Sellow;* "Flora von Mattogrosso," "*Dr. Pilger,*" 1899; Plantae Chilensis, *Otto Buchtein;* Peru,

C. M. Belshaw; Colombia, *Herbert H. Smith, H. W. Vogelmann.*

In smaller numbers, there are specimens from nearly every other country of South America.

For an American herbarium, we have a surprisingly large number of specimens from Europe. Here are listed some of the most numerous sets. Plantae Vasculares Danicae, Plantae Scandinavicae, *Einar Söderen,* Jutland, Flora Exsiccata, Plantae Danicae, *Alfred Hansen,* Plantae Suecicae, *Emil Almquist,* Plantes de France, *E. J. Neyraut,* Plantes de France, *Fr. Sennen,* Plantae France, *C. J. Pitard,* Herbier, *C. Copineau,* Plantes des Hautes Alpes, Herbier, *A. Faure,* Silicia, *Mary F. Spencer,* Flora Ingieae (Russia), Flora Exsiccata Italica, Macedonia, *Dimonie.*

At least a few thousand specimens have come from Africa including the following important series: "Plantae Schlechterianae Occidentali-Africanae", Ex Herbario Natalense, Legit *J. Medley Wood* and *M. Franks,* Cape Government Herbarium, Austro-Africanum, Cent. XVI, Austro-Africanum, Cent. XVII, *MacOwan,* Fragmenta Florae algeriensis exsiccata, Rec. par *Ed. Lafranc,* Plantes de Tunisie, *C. J. Pitard,* Plantes d'Algerie — 1898, *Elisee Reverchon,* "*W. Schimper* pl. Abyssin."

The most interesting feature of the specimens from Africa and likewise from Europe is that a large number of them appear to have come from the Berlin Herbarium. Some of them are clearly so marked, as for instance numerous specimens from Kamerun, bearing the heading on the label: Museum Botanicum Berolinense. Thus the Pringle Herbarium may have the only extant duplicates of numbers which were destroyed when the Berlin Herbarium was bombed in March 1943.

The part of Asia best represented in the Pringle Herbarium is Japan. The specimens from that country were obtained by purchase of the early herbarium of Leopold A. Charette who collected many of them himself and who evidently exchanged with Japanese herbaria, as many of his specimens were collected by various Japanese botanists.

Many from India belong to the rare series bearing the label with the familiar heading, "Herb. Ind. Or. Hook. f. & Thomson" or "Flora of the Sikkim Himalaya" coll. G. A. Gammie; and others from "Herb. Hort. Bot. Calcuttensis" are significant. The Philippines are represented by a large series of the well known collections by E. D. Merrill and A. D. E. Elmer.

Even from the Antipodes come large collections by well known botanists. That the Australian continent is well represented is especially remarkable. Among those sheets are many from the "National Herbarium of New South Wales," coll. J. L. Boorman, J. H. Maiden, J. B. Cleland, and J. H. Camfield. Those from Western Australia were collected by Max Koch.

How many types are included in this herbarium is unknown. Of those already known and recognized, there are about 200. Formerly unrecognized types are frequently discovered. Most of these are collections by Pringle in Mexico.

A unique feature is the Pringle Index, compiled largely by Leopold A. Charette. It consists of about 15,000 cards, 3 × 5 inches, numerically arranged by collection numbers, each containing a note on the specimens of Cyrus Guernsey Pringle in Mexico. They have been compiled (1) from specimens in the Pringle Herbarium; (2) from many periodicals and especially monographs; (3) from the "Catalogo de Plantas Mexicanas" by Manuel Urbina; (4) and from "Ferns and Fern Allies of Chihuahua" by I. W. Knobloch and D. S. Correll. The cards give references to citations, changes in identification and often indicate by international symbols the names of herbaria where duplicates are to be found. The code symbol used internationally to designate the Pringle Herbarium is VT, obviously selected because it is the state herbarium of Vermont.

Support of the Pringle Herbarium comes from an endowment of $35,000. The one full-time worker is the curator. Part-time assistants, usually two at a time, are selected from among the students in the University. Altho the

turnover is rather frequent, students prove to be highly capable assistants.

The first curator was none other than Dr. Pringle himself who started his herbarium apparently in 1876. It remained his private herbarium until 1902 when it was given to the University of Vermont with him continuing as curator until the time of his death in 1911. For some years thereafter the herbarium was cared for by members of the Department of Botany without a designated curator. The second curator, E. J. Dole, who filled the office for several years, was succeeded by H. W. Vogelmann from 1955 to 1971. The present incumbent, F. C. Seymour, became curator in 1971.

The Pringle Herbarium is readily accessible at 601 Main Street, Burlington, Vermont. Its brick building, formerly a weather bureau station, is set back from the street with a driveway and parking space in the rear. Qualified botanists are cordially invited to visit the Pringle Herbarium and to make use of these rich resources.

THE PRINGLE HERBARIUM
UNIVERSITY OF VERMONT
BURLINGTON, VERMONT 05401

A RANGE EXTENSION AND A NEW SYNONYM FOR ASTRAGALUS POLARIS BENTH.

R. C. BARNEBY

In a discussion of *Astragalus* sect. *Polares* (Rydb.) Barneby I have mentioned (1964, p. 370) sect. *Vesicularia* Gontsch. (in Komarov, 1946, p. 51, 877) as a possible synonym, but as the sectional typus, *A. atlasovi* Kom., was known to me only from descriptions I could make no positive statement. Now through the kindness of Dr. I. T. Vassilczenko I have been privileged to borrow an authentic example of *A. atlasovi:* basin of Anadyr' river, 27. VII. 1933, fl., fr., *Chashevy* 1393, LE, perhaps the basis of Gontscharov's record (l. c.) of the species from Anadyrskiy Kray. The plant matches in fine detail some Alaskan specimens of *A. polaris* Benth., and leaves little doubt that *A. atlasovi* (Komarov in Feddes Repert. 13: 229. 1914. — "Legi 7. VII. 1909 in peninsulae Kamtshatka valli centrali in alpibus Kaschchan non procul a pago Pustshina.") and *A. polaris,* described from plants collected by Berthold Seeman in 1849 at Eschscholtz Bay, Alaska (BM!) are taxonomic synonyms in a strict sense, although the Siberian plant represents the phase of the species with relatively narrow, fusiform pods which was segregated in Alaska as *Homalobus amblyodon* Rydb.

The range of *A. polaris,* known up to the present only from western coastal and interior montane Alaska (Barneby, 1964, map 39), is now seen to be amphi-Beringian. This is, of course, a familiar pattern of dispersal, but has particular interest in *Astragalus,* for *A. polaris* is the first member of the genus with the chromosome number x = 12 to be recorded from Asia, where the basic number 8 is virtually ubiquitous. Asiatic groups have contributed a number of species to the astragaline flora of North America, but traffic in the reverse direction through Beringia has not been recognized hitherto.

Starting from the assumption that the plant from

Anadyr' is indeed conspecific with Kamtchatkan *A. atlasovi,* an assumption fully supported by the protologue of the latter, the monotypic sect. *Vesicularia* Gontsch. (1946) automatically falls into the synonymy of sect. *Polares* (Rydb.) Barneby, based on *Phaca* sect *Polares* Rydb. (1929).

LITERATURE CITED

BARNEBY, R. C. 1964. Atlas of N. American Astragalus. Mem. N. Y. Bot. Gard. vol. 13.
KOMAROV, V. L. (ed.) 1946. Flora S. S. S. R. vol. 12.

NEW YORK BOTANICAL GARDEN,
BRONX, NEW YORK 10458

THE STATUS OF RAMALINA SUBAMPLIATA (NYL.) FINK. IN NORTH AMERICA

Peter A. Bowler and Phillip W. Rundel

Ramalina subampliata (Nyl.) Fink is a poorly understood lichen species reported from North America by many authors. At least two distinct North American taxa, an esorediate and a sorediate form, have been attributed to *R. subampliata.* The esorediate form, discussed by Howe (1914) as *R. fastigiata* var. *subampliata,* has been reported from New Mexico (Bouly de Lesdain, 1942; Egan, 1972), although Howe (1914) strangely gave its distribution as "uncommon in the Upper Austral and Transition zones from New Hampshire to North Dakota south to Louisiana and Florida." We have examined specimens from Arizona and New Mexico. The sorediate form has been collected in Alberta, Canada. This paper is the result of a study made to correctly determine the proper identity of *R. subampliata* in North America.

The new combination made by Fink (1935) of *R. subampliata* from *R. calicaris* var. *subampliata* Nyl. included an orthographic error, the specific epithet being misspelled as *subamplicata.* Although some subsequent authors have corrected this error (Bouly de Lesdain, 1942; Follman and Huneck, 1968), most Americans have perpetuated it (Hale and Culberson, 1970; Egan, 1972).

An examination of syntypes in the Nylander Herbarium. Botanical Museum, Helsinki, annotated as *R. calicaris* var. *subampliata* by Nylander himself, revealed seven collections. Fragments of each of these collections were analyzed chemically by thin-layer chromatography using Merck silica gel F-254 TLC plates in a benezene:dioxane:acetic acid solvent system (90:25:4 v/v/v), developed with 10% H_2SO_4 and heat (Culberson and Kristinsson, 1970).

hb. Nyl. 37286. France; *Lenormand.* Unknown acid A.

hb. Nyl 37284. Portugal; *Welwitsch*. Unknown acid A. (as forma *pyrifera*).

hb. Nyl. 37283. India, Nilgherrensibus; *Perrotet*. Sekikaic acid, unknown acid B. (as forma *subpapillosa*).

hb. Nyl. 37290. India, Northwest Himalaya, Pangi. Collector unknown; usnic acid.

hb. Nyl. 37319. Scotland, Barcaldine; *Crombie* 1880. No medullary substances.

hb. Nyl. 37282. Corsica, Bonifacio; *Norrlin* 1877. Unknown acid C, usnic acid. (annotated *R. canariensis* Steiner by Magnusson).

hb. Nyl. 37285. France, Pyrenees-Orientales, Forca Real. Collector unknown, 1872. Evernic acid (?).

The problems involved in selecting a lectotype for *R. subampliata* are complicated by the fact that distinct morphological differences occur among these seven collections. Clearly, more than a single species is included. The observed variations in thallus chemistry reinforce this view.

Howe (1914) selected a lectotype for his new combination *R. fastigiata* var. *subampliata* based on hb Nyl. 37282 from Corsica. His description and photograph are of this collection. Unfortunately, the collection date on this packet is 1877, seven years after the original description was published. Of the seven collections listed above, the latter three (37319, 37282, 37285) all postdate the original description of the taxa, and thus cannot be considered as syntypes.

Nylander's original description of *R. calicaris* var. *subampliata* is as follows:

"thalli laciniis latioribus (latit. circiter 6-12 millim., altit. 5-10 centim.) et facie jam *Ramalinae fraxineae* jamve *fastigiatae*, sporis vero rectis mox distincta.

Occurrit haecce in Gallia occidentali (etiam ad Parisios), in Lusitania (Welwitsch), in Algeria et in India orientali (montibus Nilgherrensibus, Himalaya).

In Lusitania adest forma sporis saepius pyriformibus

(vel quidem infra subcaudatis), quae dici possit *pyrifera*. Forma *subpapillosa* thallo magis rugoso, marginibus (et quoque lateribus) papillis minutis apice saepe albo-sorediellis exasperato, obvenit in India orientali, Nilgherris (Perrottet)."

From this description, three of the remaining four collections appear to be mentioned by Nylander. The Welwitsch (37284) and Perrotet (37283) collections are clearly the packets he examined and designated f. *pyrifera* and f. *subpapillosa,* respectively. The Lenormand collection (37286) from "Gallia occidentali" must be considered the logical choice as the letcotype for this taxa. Although the Welwitsch collection of f. *pyrifera* is fragmentary, it appears to morphologically be similar to the lectotype in its cortical and apothecial characteristics as well as being chemically identical. The Perrotet collection of f. *subpapillosa* is both morphologically and chemically distinct.

The remaining collection on the above list (37290) from India is not mentioned in the original description. It is both morphologically and chemically distinct from any of the three collections mentioned in Nylander's description.

The single specimen (Fig. 1) in the Lenormand collection (37286) is 7 cm. long, sparsely branched with branches up to 0.7 cm wide. Other characteristics are as follows: rigid, strongly flattened; surfaces indistinguishable with longitudinally oriented furrows in the shiny and smooth (though occasionally bumpy), virescent cortex; branch tips narowing; no isidia or soredia; medulla white; apothecia marginally disposed the length of the branches; the disk more or less flattened, pale, up to 4 mm in diameter.

The packet of f. *subpapillosa* (37283) consists of two morphologically and chemically similar plants, the largest being 6 cm long. Other characteristics are: sparsely branching, the branches up to 0.75 cm wide, rigid and flattened; surfaces indistinguishable and white-papillate with longitudinal and transverse furrows; the branch tips

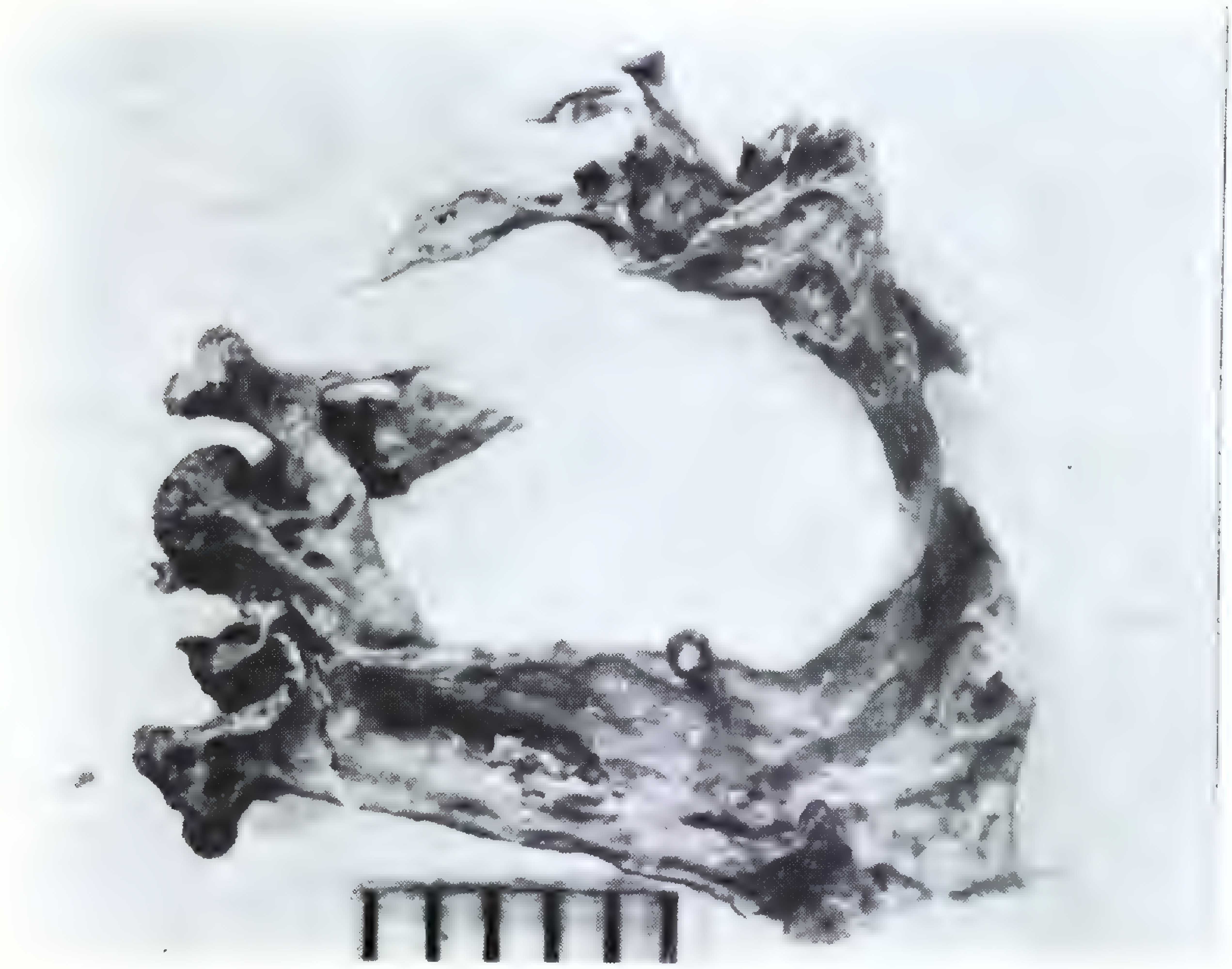


Figure 1. Lectotype of *Ramalina subampliata* (Nyl.) Fink; scale in mm. (Photograph by B. Gassner).

narrowing; the lacunose surface of cortex dull, apothecia marginal and laminal, subterminal, disk pale, up to 3 mm in diameter, flat to convex, morphologically and chemically it differs distinctly from the leucotype.

There is no question that North American reports of *R. subampliata* are incorrect. Neither the specimens figured by Howe in 1914 (hb. Nyl. 37282) from Corsica nor by Fink (1935) from New Mexico are conspecific with the lectotype of *R. subampliata* (hb. Nyl. 37286). It seems probable that chemical reports of usnic acid in Himalayan specimens of *R. subampliata* (Follmann and Huneck, 1968; Sarma and Huneck, 1968), are based not on this species, but on a taxa conspecific with Himalayan material mentioned earlier in this paper (hb. Nyl. 37290). More research will be necessary to properly assess the taxonomic position of North American taxa formerly reported as *R. subampliata*.

LITERATURE CITED

BOULY DE LESDAIN, M. 1942. Lichens de l'Etat de New Mexico (U.S.A.) recueillis par le Frere G Arsene Brouard. Rev. Bryol. Lichen. **12**: 44-66.

CULBERSON, C. F. 1970. Supplement to "Chemical and Botanical Guide to Lichen Products." Bryologist **73**: 177-377.

CULBERSON, C. F. and H. KRISTINSSON. 1970. A standardized method for the identification of lichen products. Jour. Chromatogr. **46**: 85-93.

EGAN, R. S. 1972. Catalog of the Lichens of New Mexico. Bryologist **75**: 7-35.

FINK, B. 1935. The Lichen Flora of North America. Univ. of Mich. Press, Ann Arbor.

FOLLMAN, G. and S. HUNECK. 1968. Mitteilung uber Flechteninhaltsstoffe. LXI. Zur Chemotaxonomie der Flechtenfamilie Ramalinaceae. Willdenowia **5**: 181-216.

HALE, M. E., JR. and W. L. CULBERSON. 1970. A Fourth Checklist of the Lichens of the Continental United States and Canada. Bryologist **73**: 499-543.

HOWE, R. H. 1914. North American species of the genus Ramalina. Part IV. Bryologist **17**: 17-27.

NYLANDER, W. 1870. Recognitio Monographica Ramalinarum. Bull. Soc. Linn. Normand. II, **4**: 108-180.

SARMA, K. G. and S. HUNECK. 1968. Uber Flechteninhaltsstoffe. 52. Mitteilung: Uber die Inhaltsstoffe einiger Flechten aus dem Himalaja. Die Pharmazie **23**: 583-584.

DEPARTMENT OF POPULATION AND
ENVIRONMENTAL BIOLOGY,
UNIVERSITY OF CALIFORNIA,
IRVINE, CALIFORNIA 92664.

THE VASCULAR FLORA OF KENT ISLAND, GRAND MANAN, NEW BRUNSWICK*[1]

JOHN MCCAIN, R. B. PIKE and A. R. HODGDON

In the Grand Manan cluster of islands at the entrance of the Bay of Fundy there are three neighboring isles which are the Kent Island group. Kent, the largest, has 150 acres, Hay 50 and Sheep Island only 20. These somewhat remote islands are set off by themselves as the outermost of the Grand Manan Archipelago. Kent Island lies about 15 miles east of Cutler, Maine, the nearest point on the mainland.

Since Kent Island is an important nesting place for Herring gulls, Black guillemots, Leach's petrels and other pelagic birds it holds great interest for ornithologists and has been maintained as a biological station by Bowdoin College since 1934.

During the second and third seasons of the Kent Island station, Dr. David Potter of Clark University compiled lists of the vascular species of Kent and the two neighboring islands, the results of which were published in the first and third annual reports of the Bowdoin Scientific Station (1936) (1937). Unfortunately these lists did not receive wide circulation and only came to the attention of the second and third authors of this paper in 1966 through Dr. Philip Sawyer of the Zoology Department at the University of New Hampshire.

When Professor Charles A. Weatherby and John Adams published their excellent flora of Grand Manan (1945) there was no mention of Potter's lists nor of his collections which had been placed in the herbarium at Clark University. This is not surprising in view of the obscure publication of the lists, but it is much more difficult to explain the

*This paper is published with the approval of the Director of the Bowdoin Scientific Station as Contribution No. 40.

[1]Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 668.

failure of communication between Professor Weatherby and Dr. Potter who knew each other and who must have met often at the Gray Herbarium and at meetings of the New England Botanical Club. Furthermore, Weatherby and Adams' paper made eighteen specific citations of plants growing on Kent or Hay Island.

In 1970 Pike and Hodgdon with Potter's lists in hand studied his collections at Clark University. Funds had been granted in support of this study and a subsequent field survey of the Kent Island flora. At about the same time they received, as editors of *Rhodora*, a letter from McCain, expressing interest in submitting a paper on the flora and vegetation of Kent Island. The present paper brings together all contributions to our knowledge of the Kent Island flora.

The first author (McCain) made extensive collections in 1968 and 1969 on Kent, Hay and Sheep Islands. His specimens are now deposited in the herbaria of the University of New Hampshire and Albion College, Albion, Michigan. The second and third authors visited Kent Island for two days in 1970 and were able to add a few additional taxa in groups of special interest to them. Their collections also have been placed in the herbarium of the University of New Hampshire.

Each of the four independent studies made of Kent and associated islands has added appreciably to the flora. The work of the senior author in 1968-69 resulted in 61 additions, and the most recent visit by Pike and Hodgdon supplied six more from Kent Island alone. It is doubtful, however, that further gleaning would be as profitable.

The composite list of species of vascular plants from Kent, Hay and Sheep now includes 142 genera with 240 species and 10 additional varieties representing 54 families. Any taxa not found on Kent Island are indicated in the following list as coming from Hay or Sheep, thus permitting an assessment of the total vascular flora of Kent Island itself. It should be noted also that twenty-eight species in

the flora have not been previously listed for Grand Manan. Most of these species are either halophytic or boreal.

The nomenclature is based essentially on Seymour (1969), the most up-to-date major treatment of vascular plants of the general region. However, the authors prefer not to follow Seymour in splitting off other genera from *Pyrus* and *Vaccinium* as these groups are conservatively understood. The blueberries and the Rosaceae, therefore, are listed according to the 8th Edition of *Gray's Manual*.

We wish to thank Dr. R. F. Nunnemacher for his special kindnesses to Pike and Hodgdon on the occasion of two pleasant visits to Clark University. All of us also were granted the utmost in hospitality by Dr. Charles E. Huntington, the director of the Bowdoin Science Station on Kent Island, during the course of our work. A grant from the University of New Hampshire Central University Research Fund (CURF 391) supported travel to Clark University and to Kent Island by Pike and Hodgdon. McCain's work on Kent Island was supported by National Science Foundation Undergraduate Research Participation Grants GY-4343 in 1968 and GY-6095 in 1969. He acknowledges the taxonomic advice of Dr. E. A. Stowell of Albion College and Dr. E. G. Voss and Dr. W. H. Wagner of the University of Michigan, and the support and encouragement of Dr. Clara L. Dixon of Albion College.

List of vascular plants found growing on Kent Island.

EQUISETACEAE

Equisetum arvense L. var. *boreale* (Bong.) Ledeb.

E. sylvaticum L. var. *pauciramosum* Milde.

LYCOPODIACEAE

Lycopodium annotinum L. var. *acrifolium* Fern.

L. obscurum L. forma *dendroideum* (Michx.) Blomquist & Correll. (Hay Island only)

OSMUNDACEAE

Osmunda cinnamomea L.

POLYPODIACEAE

Onoclea sensibilis L. (Hay Island only)

* *Thelypteris palustris* (Salisb.) Schott var. *pubescens* (Lawson) Fern.
Dryopteris spinulosa (O. F. Mueller) Watt. var. *americana* (Fischer) Fern.
D. cristata (L.) Gray
* *Dennstaedtia punctilobula* (Michx.) Moore
Athyrium filix-femina (L.) Roth. var. *michauxii* (Sprengel) Farw. forma *rubellum* (Gilbert) Farw.

PINACEAE

Abies balsamea (L.) Miller
Picea glauca (Moench.) Voss.
P. rubens Sarg.
P. mariana (Miller) BSP.
Larix laricina (DuRoi) K. Koch
* *Juniperus communis* L. var. *depressa* Pursh.

TYPHACEAE

* *Typha latifolia* L.

SPARGANIACEAE

* *Sparganium americanum* Nutt.

ZOSTERACEAE

Zostera marina L. var. *stenophylla* Ascherson & Graebner.

JUNCAGINACEAE

Triglochin maritimum L.
T. palustre L.

GRAMINEAE

Festuca rubra L. var. *rubra*
Puccinellia paupercula (Holm.) Fern. & Weath. var. *alaskana* (Scribner & Merr.) Fern. & Weath.
Poa annua L.
* *P. compressa* L.
P. pratensis L.
Poa palustris L.
Agropyron repens (L.) Beauv. forma *aristatum* (Schum.) Holmb.
A. repens (L.) Beauv. forma *trichorrachis* Rohlena.
A. repens (L.) Beauv. forma *pilosum* (Scribner) Fern.
Hordeum jubatum L.

Elymus arenarius L. var. *villosus* Meyer
* *E. virginicus* L.
Deschampsia flexuosa (L.) Trin.
Danthonia spicata (L.) Beauv.
Calamagrostis canadensis (Michx.) Nutt. var. *canadensis*
Ammophila breviligulata Fern.
* *Agrostis stolonifera* L. var. *major* (Gaud.) Farw.
A. stolonifera L. var. *palustris* (Hudson) Farw.
A. tenuis Sibth, forma *aristata* (Sinclair) Wiegand
* *A. scabra* Willd.
* *A. perennans* (Walter) Tuck.
* *Cinna arundinacea* L.
† *C. latifolia* (Trev.) Griseb.
Phleum pratense L.
Alopecurus pratensis L.
Spartina alterniflora Loisel.
Anthoxanthum odoratum L.

CYPERCEAE

* *Eleocharis smallii* Britton var. *major* (Sonder) Seymour
E. halophila Fern. & Brackett.
E. elliptica Kunth.
Scirpus americanus Pers.
* *S. atrovirens* Willd.
* *S. cyperinus* (L.) Kunth. forma *pelius* Fern.
S. atrocinctus Fern. (Hay Island only)
Eriophorum spissum Fern.
E. angustifolium Honckeny
E. virginicum L.
Carex stipata Muhl. (Hay Island)
C. trisperma Dewey
C. canescens L. var. *disjuncta* Fern.
* *C. canescens* L. var. *subloliacea* Laestad.
C. brunnescens (Pers.) Poiret. var. *sphaerostachya* (Tuck.) Kukenthal.
C. cephalantha (Bailey) Bickn.
* *C. tribuloides* Wahlenb.
C. hormathodes Fern.

RANUNCULACEAE

Ranunculus cymbalaria Pursh.
R. acris L.
Thalictrum polygamum Muhl. (Hay Island only)
Coptis groenlandica (Oeder) Fern.

CRUCIFERAE

Capsella bursa-pastoris (L.) Medicus
Cakile edentula (Bigelow) Hooker
Rorippa islandica (Oeder) Borbas var. *hispida* (Desv.) Butters & Abbe.
* *R. islandica* (Oeder) Borbas var. *fernaldiana* Butters & Abbe.

SARRACENIACEAE

Sarracenia purpurea L.

DROSERACEAE

Drosera rotundifolia L.

CRASSULACEAE

* *Sedum telephium* L. forma *purpureum* (L.) Seymour
S. rosea (L.) Scop.

SAXIFRAGACEAE

Ribes hirtellum Michx.
R. lacustre (Pers.) Poiret.
R. glandulosum Grauer.

ROSACEAE

Spiraea latifolia (Ait.) Borkh.
Pyrus malus L.
Pyrus floribunda Lindl.
Pyrus americana (Marsh) DC.
Pyrus decora (Sarg.) Hyland
Fragaria virginiana Duchesne
Potentilla norvegica L.
Potentilla anserina L.
Filipendula ulmaria (L.) Maxim. (Hay Island only)
Rubus chamaemorus L.
Rubus idaeus L. var. *canadensis* Richardson
Rubus hispidus L.
Rosa rugosa Thunb.

LEGUMINOSAE

Trifolium pratense L. var. *sativum* (Miller) Schreber (Hay Island)

T. repens L.
T. agrarium L. (Hay Island only)
Vicia cracca L. (Hay Island only)
Lathyrus japonicus Willd. var. *pellitus* Fern.

OXALIDACEAE

Oxalis montana Raf.

CALLITRICHACEAE

Callitriche verna L. (Hay Island only)

EMPETRACEAE

Empetrum nigrum L.

BALSAMINACEAE

Impatiens capensis Meerb. forma *immaculata* (Weath.) Fern. & Schub.

GUTTIFERAE

Hypericum virginicum L. var. *fraseri* (Spach.) Fern.

VIOLACEAE

Viola cucullata Aiton
* *V. septentrionalis* Greene
V. pallens (Banks) Brainerd

ONAGRACEAE

Epilobium angustifolium L.
* *E. palustre* L.
E. glandulosum Lehm. var. *adenocaulon* (Haussk.) Fern.
Oenothera perennis L.
Circaea alpina L.

HIPPURIDACEAE

Hippuris vulgaris L. (Hay Island only)

ARALIACEAE

Aralia hispida Vent.

UMBELLIFERAE

Carum carvi L.
Ligusticum scothicum L.
Coelopleurum lucidum (L.) Fern.
Heracleum maximum Bartr. (Hay Island only)

CORNACEAE

Cornus canadensis L.

PYROLACEAE

Moneses uniflora (L.) Gray
* *Monotropa uniflora* L.

† *Monotropa hypopithys* L.

ERICACEAE

Ledum groenlandicum Oeder

* *Rhododendron canadense* (L.) Torrey

Kalmia angustifolia L.

* *Cassandra calyculata* (L.) D. Don. var. *angustifolia* (Aiton) Seymour

* *Chiogenes hispidula* (L.) T. & G.

Vaccinium angustifolium Aiton. var. *laevifolium* House

V. vitis-idaea L. var. *minus* Lodd.

V. oxycoccus L.

‡ *V. oxycoccus* L. var. *ovalifolium* Michx.

PRIMULACEAE

Lysimachia terrestris (L.) BSP.

Trientalis borealis Raf.

Glaux maritima L.

PLUMBAGINACEAE

Limonium nashii Small

GENTIANACEAE

Menyanthes trifoliata L. var. *minor* Raf.

CONVOLVULACEAE

Convolvulus sepium L.

Convolvulus sepium L. forma *malachophyllus* Fern.

BORAGINACEAE

Mertensia maritima S.F. Gray

LABIATAE

Scutellaria epilobiifolia A. Hamilton

Galeopsis tetrahit L. var. *bifida* (Boenn.) Lej. & Court.

* *Lycopus virginicus* L.

Lycopus uniflorus Michx.

SCROPHULARIACEAE

Euphrasia randii B. L. Robinson (Sheep Island only)

Euphrasia americana Wettst.

Rhinanthus crista-galli L. var. *fallax* (Wimmer & Grab.) Druce

PLANTAGINACEAE

* *Plantago major* L.

Plantago juncoides Lam. var. *decipiens* (Barneoud) Fern.

* *Plantago juncoides* Lam. var. *glauca* (Hornem.) Fern.
† *Plantago oliganthos* R. & S.

RUBIACEAE

Galium trifidum L.

CAPRIFOLIACEAE

Lonicera canadensis Bartram
Linnaea borealis L. var. *americana* (Forbes) Rehder.

COMPOSITAE

* *Solidago sempervirens* L.
Solidago rugosa Miller var. *villosa* (Pursh.) Fern.
Solidago graminifolia (L.) Salisb. var. *nuttallii* (Greene) Fern.
‡ *Solidago macrophylla* Pursh.
Aster foliaceus L. var. *arcuans* Fern.
* *Aster johannensis* Fern.
Aster acuminatus Michx.
* *Aster nemoralis* Aiton
‡ *Aster* × *Blakei* (Porter) House
Aster umbellatus Miller
Anaphalis margaritacea (L.) B.&H. var. *subalpina* Gray.
* *Anaphalis margaritacea* (L.) B.&H. var. *intercedens* Hara.
* *Gnaphalium uliginosum* L.
Ambrosia artimisiifolia L. var. *elatior* (L.) Descortils
* *Bidens cernua* L.
Bidens frondosa L.
Achillea millefolium L.
‡ *Matricaria maritima* L. var. *agrestis* (Knaf.) Wilmott.
Matricaria matricarioides (Less.) Porter
Chrysanthemum leucanthemum L. var. *pinnatifidum* Lecoq. & Lamotte
Tanacetum vulgare L. (Hay Island only)
‡ *Senecio vulgaris* L.
Senecio sylvaticus L.
Cirsium vulgare (Savi) Tenore
Cirsium arvense (L.) Scop.
Leontodon autumnalis L. var. *pratensis* (Link.) W. D. J. Koch

Taraxacum officinale Weber
Sonchus asper (L.) Hill.
Hieracium aurantiacum L.
Hieracium floribundum Wimm. & Grab.
Hieracium pratense Tausch.
Hieracium pilosella L.

STATISTICAL SUMMARY

54 Families
142 Genera
240 Species (or 239 spp. and 1 hybrid)
10 Varieties

Unless otherwise noted, species were collected and identified by John McCain in 1968 and 1969.

* Species collected by Dr. David Potter 1935-1936.
† Species listed by C. A. Weatherby and J. Adams, 1945.
‡ Species collected by Dr. Albion Hodgdon and Radcliffe Pike in 1970.

LITERATURE CITED

POTTER, DAVID. 1936. List of Kent's Island Flowering Plants 1935. Bull. Bowdoin Sci. Sta. **1**: 10-12.

————. 1937. Plants found growing on Kent's Island 1935-1936. Bull. Bowdoin Sci. Sta. **3**: 19-26.

WEATHERBY, C. A. and J. ADAMS. 1945. A list of the vascular plants of Grand Manan, Charlotte County, New Brunswick. Canada. Contrib. Gray Herbarium **158**: 96 pp.

DEPARTMENT OF BIOLOGY
ALBION COLLEGE
ALBION, MICHIGAN 49224

DEPARTMENTS OF PLANT SCIENCE
AND BOTANY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, N. H. 03824

Correction in Book Review, Flora of the Galápagos Islands

The meaning of the sentence on lines 14-17 on page 144 of Rhodora for March 1973 is quite different from that intended. The sentence should read as follows: The presence of the endemic *Miconia* and *Cyathea* would seem to depend on reasonably moist conditions having obtained for some time in the areas where they are now growing or in places not far away.

Librarians and others who are interested in this review are advised to substitute the word *now* for *not*.

— A. R. HODGDON

INSTRUCTIONS FOR CONTRIBUTORS TO RHODORA

Manuscripts must be double-spaced or preferably triple-spaced (not on corrasable bond), and a list of legends for figures and maps provided on a separate page. Footnotes should be used sparingly, as they are usually not necessary. Do not indicate the style of type through the use of capitals or underscoring, particularly in the citations of specimens, except that the names of species and genera may be underlined to indicate italics in discussions. Specimen citations should be selected critically especially for common species of broad distribution. Systematic revisions and similar papers should be prepared in the format of "The Systematics and Ecology of Poison-Ivy and the Poison-Oaks," W. T. Gillis, Rhodora 73: 161-237, 370-443. 1971, particularly with reference to the indentation of keys and synonyms. Papers of a floristic nature should follow, as far as possible, the format of "Contribution to the Fungus Flora of Northeastern North America. V.," H. E. Bigelow & M. E. Barr, Rhodora 71: 177-203. 1969. For bibliographic citations, a recommended list of standard journal abbreviations is given by L. Schwarten & H. W. Rickett, Bull. Torrey Bot. Club 85: 277-300. 1958.

Volume 75, No. 802, including pages 169-324, was issued June 29, 1973.

CONTENTS: — *continued*

Palynological Evidence for the Late Glacial Occurrence of Pringlea and Lyallia on Kerguelen Islands
Steven B. Young and *Eileen K. Schofield* 239

Phytogeography of the Carices of Virginia
A. M. Harvill, Jr. 248

The Marine Algae of Virginia and Maryland Including the Chesapeake Bay Area
Franklyn D. Ott 258

The Pringle Herbarium
Frank C. Seymour 297

A Range Extension and a New Synonym for Astragalus polaris Benth.
R. C. Barneby 304

The Status of Ramalina subampliata (Nyl.) Fink in North America
Peter A. Bowler and *Phillip W. Rundel* 306

The Vascular Flora of Kent Island, Grand Manan, New Brunswick
John McCain, R. B. Pike and *A. R. Hodgdon* 311

Correction in Book Review, Flora of the Galápagos Islands
A. R. Hodgdon 323

Instructions for Contributors 324

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

ALBION REED HODGDON, Editor-in-Chief

ROLLA MILTON TRYON
RADCLIFFE BARNES PIKE
STEPHEN ALAN SPONGBERG
GERALD JOSEPH GASTONY
ALFRED LINN BOGLE
} **Associate Editors**

Vol. 75 September, 1973 No. 803

CONTENTS:

Biosystematic Study of Chamaesaracha (Solanaceae)
John E. Averett 325

Some Notes on the Flora of the Southern States, Particularly Alabama and Middle Tennessee
Robert Kral 366

Additions to the Bahama Flora since Britton and Millspaugh
William T. Gillis, Richard A. Howard, and George R. Proctor 411

Revision of the Genus Pontederia L.
Richard M. Lowden 426

(Continued on Inside Back Cover)

The New England Botanical Club, Inc.
Botanical Museum, Oxford St., Cambridge, Mass. 02138

RHODORA. — A quarterly journal of botany, devoted primarily to the flora of North America and floristically related areas. Price $10.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes, and single copies are available. For information and prices write RHODORA at address given below.

Scientific papers and notes, relating directly or indirectly to the plants of North America, will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. All manuscripts should be double-spaced throughout. Please conform to the style of recent issues of the journal. Illustrations can be used only if the cost of engraver's blocks is met through the author or his institution. Forms may be closed five weeks in advance of publication. Extracted reprints, if ordered in advance, will be furnished at cost.

Address manuscripts and proofs to Albion R. Hodgdon,
Dept. of Botany, Nesmith Hall, University of New Hampshire,
Durham, New Hampshire 03824

Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of March, June, September or December.

Second Class Postage Paid at Boston, Mass.

MANUFACTURED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Vol. 75 September, 1973 No. 803

BIOSYSTEMATIC STUDY OF CHAMAESARACHA (SOLANACEAE)[1]

JOHN E. AVERETT[2]

Chamaesaracha was established as a genus by A. Gray in 1876, having previously been recognized as a section of *Saracha*. The genus has been treated in part by Gray (1878) and by Rydberg (1896). However, an inclusive revision of *Chamaesaracha* has not been forthcoming.

As herein conceived, *Chamaesaracha* is an exclusively North American genus with its greatest concentration of species in the Chihuahuan desert. A total of 18 species has been attributed to the genus, but only 7 are recognized in the present treatment. The remaining 11 have been relegated to synonymy or have been transferred to other genera (see excluded species).

CHROMOSOME STUDIES

Meiotic chromosomes were observed best at anaphase I, because of clumping and poor staining of the chromosomes in diakinesis and metaphase I. The latter is particularly notable in polyploid cells. Except for several triploid individuals, meiosis appeared to be regular with equal separa-

[1]Part of a doctoral dissertation presented to the faculty of the Graduate School of The University of Texas at Austin.

[2]Department of Biology, University of Missouri — St. Louis 63121 and Missouri Botanical Garden.

tion of chromosomes at anaphase I. All chromosome numbers reported here are from meiotic material.

Several of the earlier chromosome number reports for *Chamaesaracha* (Powell and Averett, 1967) require clarification in keeping with the results of my present systematic account of the genus. In the 1967 paper, counts were listed for the following: *C. coronopus* ($n = 24$); and *C. cf. sordida* ($n = 12, 18, 36$). With the exception of *C. sordida* and *C. cf. sordida*, all of the 1967 reports were applied to taxa that were correctly identified. (*C. cf. crenata* is *C. crenata*). The following corrections must be noted in regard to the 1967 reports attributed to *C. sordida* and *C. cf. sordida*: The $n = 12$ and $n = 18$ collections identified as *C. cf. sordida* are now recognized as *C. sordida*. The $n = 24$ populations referred to *C. sordida* are now regarded as *C. coniodes*, a species then regarded as conspecific with *C. sordida*. *Chamaesaracha cf. sordida* ($n = 36$), except for *Averett* 155, is now recognized as *C. coronopus*. Collection 155 is *C. pallida*, a newly described taxon (Averett, 1971). Listed in Table 1 are additional counts for the taxa first reported in 1967, as well as reports for the remaining species of *Chamaesaracha*.

Polyploidy is found in five of the seven species of *Chamaesaracha*, four being typically polyploid. Although there are areas lacking convincing data some comment may be made regarding the origin of selected polyploids. Because each is somewhat unique, they are considered individually in the following discussion.

Chamaesaracha sordida. There is evidence for an autopolyploid origin of the triploid ($n = 18$) individuals in *C. sordida*. In a regional study of the taxon, a triploid plant was collected from a population in northern Culberson County, Texas. Meiosis in this individual was irregular. Diakinetic and metaphase chromosomes were not clearly observed, but unequal segregation of 36 chromosomes could be observed in anaphase I. From 14 to 22 chromosomes could be found going to one side of the diad in about 100 cells, but 18 choromsomes could be observed in one side

or the other of an equivalent number of cells. The irregularity was first attributed to hybridization between a diploid and a tetraploid. However, subsequent resampling of the area from which the triploid individual was collected indicated that only diploid individuals occurred in the population concerned. (Chromosome numbers were ascertained for about 15 individuals from the general area; all were diploid with $n = 12$).

Two additional triploid individuals have been found in widely disjunct populations of the same species. These have not been carefully studied, but in one population in Yoakum County, Texas, chromosome numbers from three individuals were determined (*Averett & Tomb* 320A, B, C). One of these was triploid and the other two were diploid. The only other triploid found in this species came from a population in Lincoln County, New Mexico.

The morphology and flavonoid chemistry of the triploids referred to above are nearly identical to that of the diploids. Considering the sporadic occurrence of the triploids, the plants do not seem to have a common origin nor do they appear to be the result of the interspecific hybridization. Rather, each appears to have had an independent origin through the chance fertilization of an unreduced gamete with a normal haploid gamete. The additional set of chromosomes would account for the observed unequal chromosomal segregation found in the triploid populations.

Chamaesaracha coronopus. This species is typically tetraploid with $n = 24$, but occasional diploids ($n = 12$) and hexaploids ($n = 36$) are found in western and southwestern Texas and also in southeastern Arizona. Unlike the triploids of *C. sordida,* the hexaploids are quite fertile. Meiosis appears to be regular, at least in anaphase I, and unequal segregation has not been observed. Additionally, seed set and germination is approximately equivalent to that of the tetraploids. Because of their apparent fertility, an autoploid origin such as proposed in *C. sordida* does not seem likely. However, as in the triploid *C. sordida,* there is no evidence that another taxon has contributed

to the genome of the hexaploids in question, even though *C. sordida* ($n = 12$) does occur sympatrically in some areas with *C. coronopus*. Rather, the hexaploids concerned appear to be derived from hybridization between the diploid and tetraploid races of *C. coronopus*. Chemical and morphological data are currently being accumulated and preliminary results appear to confirm this suggestion.

Evidence is not available to suggest the origin of the tetraploid race of *C. coronopus* and the remaining polyploid species of *Chamaesaracha*. However, two species, *C. pallida* ($n = 36$) and *C. edwardsiana* ($n = 24$) are believed to be closely related to, and derived from, *C. coronopus* or its ancestors. *Chamaesaracha coniodes* is not particularly close to any of the former species and is likely independently derived. Autoploidy or segmental alloploidy may account for the polyploidy in both *C. coniodes* and *C. coronopus* $n = 24$.

Table I. Chromosome numbers and number of plants counted of *Chamaesaracha*.[3]

Taxon	Chromosome number (n)	Number of plants counted
C. coronopus[4]	12	3
C. coronopus	24	26
C. coronopus	36	5
C. coniodes	24	68
C. crenata	12	8
C. edwardsiana	24	11
C. pallida	36	6
C. sordida	12	53
C. sordida	18	3
C. villosa	12	8

[3]Data from Powell & Averett (1967) and Averett (1970).
[4]Not previously reported. Discussion & localities in text.

FLAVONOID STUDIES

Populations were sampled for flavonoid studies so as

to represent as much of the total range, as well as intraspecific variability, of each of the species as time and opportunity permitted. One to ten individuals from the various populations were analyzed to determine the extent and significance of inter- and intrapopulational variation. Voucher specimens for the populations studied are deposited in the Herbarium of the University of Texas at Austin. Duplicate specimens will be distribued at a later date.

Flavonoids were extracted overnight from leaf material with 85% methanol and separated by two-dimensional paper chromatography. Solvent systems of t-butanol, glacial acetic acid, and water (3:1:1 v/v) and 15% glacial acetic acid were employed. The compounds detected were then characterized structurally by ultraviolet spectroscopy and appropriate acid and enzyme hydrolyses. The techniques utilized for chromatographic and spectral analysis follow those presented by Mabry, Markham and Thomas (1971).

All of the compounds extracted from *Chamaesaracha* are based on either quercetin or kaempferol skeletons. Differences among the several compounds primarily reflect glycosidic substitutions, but a few methoxylated compounds also are present. Except for the methoxylated compounds, the flavonoids of *Chamaesaracha* are the same as those reported for *Leucophysalis* by Averett and Mabry (1971), but greater interspecific variability is found in *Chamaesaracha.*

Flavonoid data, in general, were found to substantiate conclusions based upon morphological data. Two-dimensional chromatographic patterns were, for the most part, species-specific, showing relatively little variation, either within or between populations of the same species. A notable exception was found in *Chamaesaracha coniodes* in which significant variations in the flavonoid patterns were observed. This species is also quite variable morphologically and much of the flavonoid variation probably reflects genetic heterogeneity from population to popula-

tion. Within the more discrete populations, however, flavonoid patterns were essentially uniform (this is also true of morphological variation).

Closely related taxa were found to have similar flavonoids; consequently, chemical data have been utilized for many of the taxonomic conclusions reached in the present study, especially in situations where morphological and chromosomal distinctions were not decisive.

BIOECOLOGY

Chamaesaracha, a closely knit genus of perennial herbs, is largely restricted to the desert regions of the southwestern United States and northern Mexico. The plants are fairly common along roadsides in early and later summer, but populations become depauperate in the hot, dry, midsummer period, being found with some difficulty, except in areas of accumulated moisture.

The plants often occur in closely clustered populations of 25-30 plants. Such populations likely originated from one or a few seeds, and are believed to be largely the result of vegetative reproduction from spreading rhizomes. In garden plots, individual plants form colonies 8-10 feet in diameter within a single growing season. Intrapopulational variation, both chemical and morphological, within these clusters is essentially absent, suggesting a single source for most of the individuals within a given population. Vegetative reproduction, along with perenniality of the rootstocks, must have much to do with the variation patterns, or lack of them, in the natural populations.

The role of vegetative reproduction and perennial habit becomes even more apparent when seed germination is considered. Although seed set is more than adequate, the percentage of seed germination is very low. In germination experiments, seeds were allowed to imbibe for about seven days. After imbibition, various exposures to light and dark were given, but the latter seemed to have little effect on germination. Typically fewer than 5% of the seeds germinated. Germination in diploid species was con-

siderably lower than in polyploid species. It is presumed that seed germination is equally poor in nature, though this may not be a valid assumption.

Since fruit with relatively high seed set are found in nature, the various insects that visit the flowers must be fairly effective pollinators. No consistent pollen vectors have been observed, but bee flies and several types of small beetles are commonly found on the flowers of *Chamaesaracha*. Evidence for self-sterility has not been obtained for any of the species, but in isolated plants in garden plots, fruit was observed only on *C. crenata*. Even in this species, however, seed set was reduced some 80% from that found in nature. In the field, probably both self and out pollination occur, with outcrossing predominating.

GENERIC RELATIONSHIPS

Chamaesaracha is included in the tribe Solaneae (Wettstein, 1895) and has generally been associated with *Physalis* and *Leucophysalis*, largely because of their similar corolla forms. It is probably most closely related to *Leucophysalis*, differing in characters of the berry; whereas *Physalis* is separated primarily by its inflated fruiting calyx, and to some extent by its flower. The Asian genus *Physaliastrum* is related to *Chamaesaracha* in much the same way that the latter is related to *Leucophysalis*. *Physaliastrum* is, however, believed to be more closely related to *Leucophysalis;* indeed, they may well be congenic (Averett, 1971). All of the species that now comprise *Leucophysalis* and *Physaliastrum* have, at one time or another, been relegated to *Chamaesaracha*. In fact, workers are not generally in accord as to the preferred treatment of these several genera of Solaneae. For example, Waterfall (1958) suggested that *Physalis* and *Chamaesaracha* might be combined and treated as subgeneric categories. If these were the only two genera involved, the merger would not be unreasonable. However, under such a treatment, the status of *Margaranthus* would be affected since it is hardly more distinct from *Physalis* than is *Chamaesaracha*, differ-

ing only in the color and urceolate form of its corolla. While the sinking of *Margaranthus* with *Physalis* may also be reasonable, it is difficult, at least for me, to accept the merger of *Chamaesaracha* and *Margaranthus*. Other genera are interrelated in a similar manner, and for that reason it seems worthwhile to consider them in more detail.

Leucophysalis was established as a monotypic genus by Rydberg (1896) to accommodate *L. grandiflora*, formerly included in *Physalis* by Hooker (1928). Fernald (1949) compared *L. grandiflora* with certain Asian species of what he considered to be *Chamaesaracha*, and as a consequence transferred *L. grandiflora* to the latter genus. However, I have recognized *Leucophysalis* as distinct from *Chamaesaracha*, and have added an additional two species (Averett, 1971). The distinctive morphological features of the two taxa are comparable to those that differentiate most of the other genera of the Solaneae. *Leucophysalis* is similar to *Chamaesaracha* with respect to characters of the flower and the fruiting calyx, but differs in having a fleshy berry with a placenta extending the entire length of the berry. In *Chamaesaracha* the berry is dry, and the placenta is mostly basal (not extending the entire length of the berry). The species of *Chamaesaracha* are extremely uniform in floral, fruit, and seed morphology and as such, departure of the fruiting character seems significant. In addition, the two taxa have quite distinct habitat preferences and occupy different geographical regions. In contrast to the arid desert habitat of *Chamaesaracha*, *Leucophysalis* is found in more mesic habitats, e.g., the Sierra Nevada of California and the Great Lakes Region.

Physaliastrum is a small Asian genus of two species distinguished from *Leucophysalis* by the form of its corolla lobes, which are not plicate (as they are in *Leucophysalis*). The berry is like that of *Leucophysalis*, further differentiating the genus from *Chamaesaracha*.

Physalis differs from *Chamaesaracha*, as well as from *Leucophysalis* and *Physaliastrum*, in having a ribbed, inflated fruiting calyx. The only genus with a structure of this type is *Margaranthus*, which, as mentioned above,

differs from *Physalis* in corolla shape. *Physalis* may be differentiated from *Chamaesaracha,* at least to some extent, on characters of the perianth. The corolla of *Physalis* is campanulate, and the flowering calyx is truncate. However, the floral morphology of *Chamaesaracha* is at least approached in a few species of *Physalis* (e.g., *P. lobata* and *P. wrightii*). *Physalis* is probably more closely related to *Margaranthus* on the basis of the fruiting calyx, and on other characters it is more closely related to *Leucophysalis* and *Physaliastrum* than it is to *Chamaesaracha.*

Nicandra is native of Peru, but is widly naturalized in the United States being found in wastelands and around old gardens. *Nicandra* is closely related to and often mistaken for *Physalis,* but differs in having 5 carpels and distinct, sagittate sepals.

Saracha is primarily a tropical genus of about 30 species extending from Peru through Central America north into northern Mexico and the southwestern United States.* *Chamaesaracha* and *Saracha* were once considered congeneric, but the two genera may be distinguished on fruiting characters. In *Saracha* the fruiting calyx is rotate and expanding at the base of a fleshy berry; in *Chamaesaracha* the fruiting calyx is tightly investing a dry berry. *Saracha* is probably not as closely related to *Chamaesaracha* as the genera mentioned above.

Oryctes is a monotypic genus of western Nevada and southeastern California, resembling *Chamaesaracha* in habit and somewhat in fruit. It is, however, easily distinguished by its small tubular flower and flat, orbicular seeds.

The few remaining genera of the Solaneae are not considered here since they are not so closely related to, and rarely confused with, *Chamaesaracha.*

---

*Recent studies by W. G. D'Arcy and Johnny Gentry indicate that the Mexican and Central American species are properly treated as *Bellinia* R. & S. Earlier suggestions of affinity between *Saracha* and *Chamaesaracha* were likely based upon these species.

KEY TO CHAMAESARACHA AND RELATED GENERA

Flowers tubular, seeds orbicular .... *Oryctes*
Flowers campanulate to repand-rotate or urceolate, seed reniform,
  Fruiting calyx expanding under and not enclosing the berry .... *Saracha*
  Fruiting calyx loosely or tightly investing the berry ...
    Calyx inflated around the berry.
      Flowers urceolate .... *Margaranthus*
      Flowers campanulate to repand-rotate.
        2 carpelate, calyx of united sepals ...... *Physalis*
        5 carpelate, calyx of distinct, sagittate-based sepals .... *Nicandra*
    Calyx tightly investing the berry.
      Berry dry, placentation mostly basal, seeds rugose-reticulate .... *Chamaesaracha*
      Berry fleshy, placentation axile, seeds punctate.
        Flowers repand-rotate .... *Leucophysalis*
        Flowers campanulate .... *Physaliastrum*

PHYLOGENETIC CONSIDERATIONS

Chamaesaracha is largely restricted to the arid regions of the southwestern United States and northern Mexico. What are believed to be the more primitive, diploid species, *C. villosa, C. crenata* and *C. sordida,* have their centers of distribution in the Chihuahuan desert of northern Mexico. Of these, *C. sordida* is the only species to have any appreciable distribution in the United States. Still, it has a distinctly southern distribution as compared to the polyploid species, *C. coronopus* and *C. coniodes. Chamaesaracha coronopus* is the most widespread species, extending essentially over the entire range of the genus; *C. coniodes* is also widespread, but does not extend so far west as *C. coronopus.* The remaining polyploid species are fairly restricted in distribution, with *C. edwardsiana* occurring primarily on the Edwards Plateau of south-central Texas and adjacent Mexico and *C. pallida* extending from the Edwards Plateau into western Texas and northern Mexico.

From the distributional data, it seems reasonable to suggest that *Chamaesaracha* had its origin in the highlands of northern Mexico, the ancestral species of which probably belonged to the more xeric members of the Madro-Tertiary Geoflora (cf. Axelrod, 1958). With continued adaptation to xeric conditions, expansion from this area was likely concurrent with the spread of an arid environment to the north and east. In that the polyploid and derived species are marginal to the Chihuahuan desert proper, it is difficult to imagine an opposing direction of migration and speciation.

The interpretation of evolutionary trends in *Chamaesaracha* is based for the most part on chromosomal and distributional data in combination with correlated morphological features. Some of the characters that I consider to be primitive and derived, at least within *Chamaesaracha*, are listed below:

	Primitive	*Derived*
1.	woody rootstock	subligneous root
2.	large, ovate, entire, and thin leaves	small, lanceolate, lobed, and thickened or leathery leaves
3.	large flowers	small flowers
4.	O-methylation of flavonoids	absence of O-methylation of flavonoids
5.	increased glycosylation of flavonoids	decreased glycosylation of flavoids

The assessment of morphological characters generally follows classical consideration for those features (i.e., perenniality is generally considered primitive, as are large flowers). Polyploidy is considered to be derived in *Chamaesaracha*, quite apart from numerical considerations, because the polyploids possess fewer of the characters considered primitive in the listing above. Hence, the fairly widesperad occurrence of polyploidy offers a sound basis upon which to establish evolutionary trends within the genus.

Considering the above, it is possible to construct a schematic representation of the proposed origin and evolution

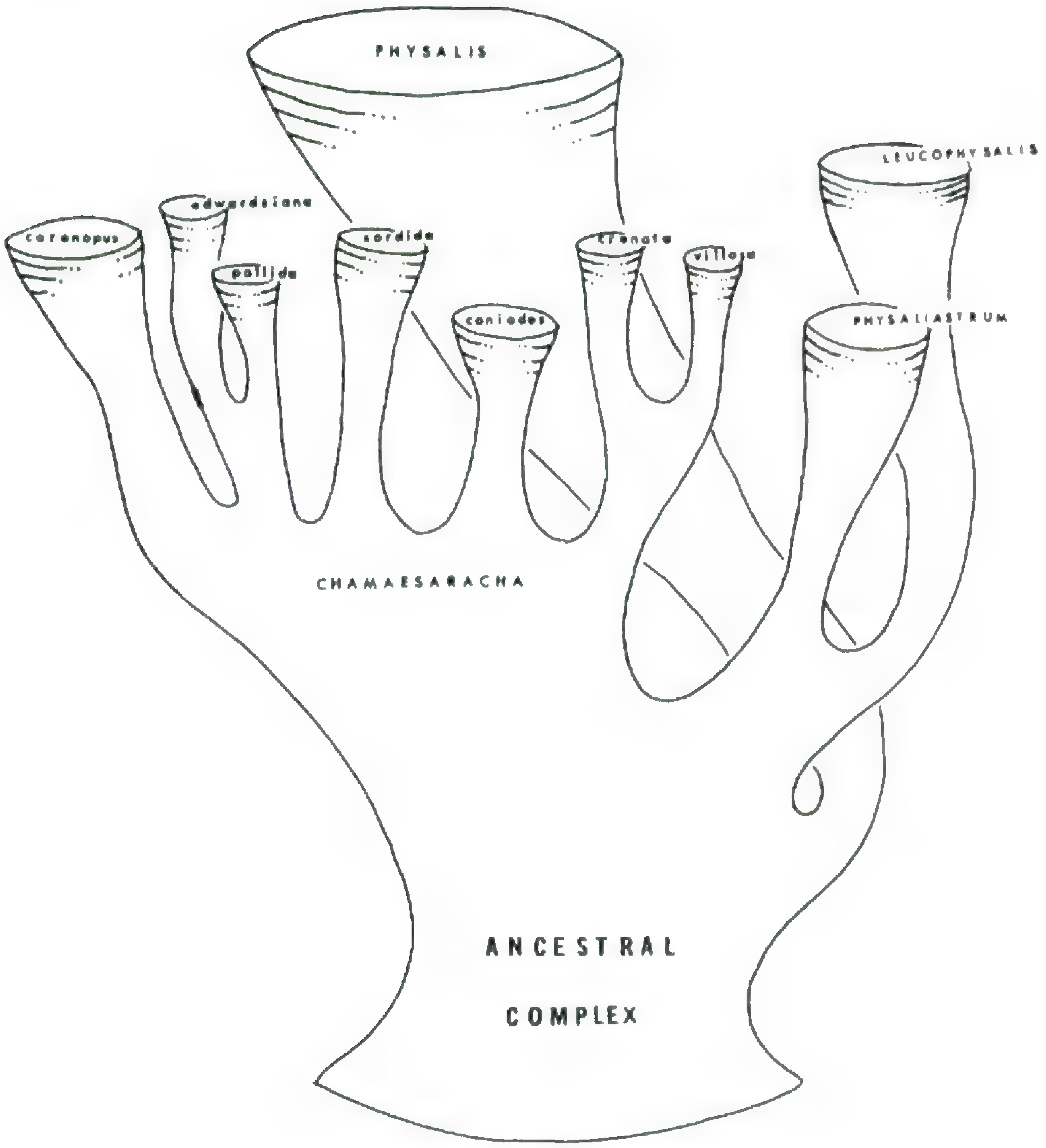


Figure 1. Hypothetical phyletic relationships within *Chamaesaracha*.

of the species of *Chamaesaracha* (Figure 1). While the diagram is highly conjectural from a phyletic point of view, it nonetheless expresses visually my views on the relationships among the taxa.

The flavonoid chemistry of the various species of the genus supports the relationships suggested in Figure 1. In what are considered to be advanced taxa, there is a general decrease of O-glycosylation and O-methylation, presumably reflecting the loss of enzymes necessary for these substitutions. In addition, the more closely related taxa (as I have grouped them) do have a greater similarity in their chromatographic profiles.

ACKNOWLEDGMENTS

A significant portion of this work, particularly the field studies, was made possible by NSF Traineeship grants for Environmental and Systematic Study while the author was a graduate student at The University of Texas at Austin. The latter part of the study was supported by a Summer research fellowship from The University of Missouri — St. Louis.

I am indebted to Drs. M. C. Johnston, T. J. Mabry, A. M. Powell, and B. L. Turner for their interest and assistance in this study. I would also like to acknowledge those herbaria from which some 2,000 specimens were borrowed..

TAXONOMIC TREATMENT

Chamaesaracha Gray

Chamaesaracha A. Gray, Bot. Calif. 1:540, 1876. TYPE SPECIES: *Chamaesaracha coronopus* (Dunal) Gray.

Saracha Ruiz & Pav. sec. Chamaesaracha Gray, Proc. Amer. Acad. 10:62. 1874.

Rhizomatous perennial herbs; stems erect, ascending, or prostrate, 10-50 cm long, much branched, round striate or angular; glabrous to variously pubescent; leaves simple, broadly ovate, ovate, rhomic, lanceolate, oblanceolate, or linear-lanceolate, entire to pinnately or irregularly lobed,

subsessile to distinctly petiolate, base attenuate to truncate, apex acute, rounded, or obtuse with veins prominent or obscure; flowers 1-5 in axils, pedicels slender, elongating and becoming curved or twisted in fruit; calyx campanulate, rounded at the base, connate ¼-¾ its length, pubescent; corolla repand-rotate, white, ochroleuceous, or yellow-green, often tinged with purple on the outer surface of the lobes, with white tomentose appendages in the throat; stamens inserted near the base of the corolla; filaments slender, ca 3 mm long, anthers yellow, ca. 1.5 mm long, dehiscing longitudinally; styles slender and somewhat curved; stigmas blunt, or minutely 2-cleft; fruit a globose berry, tightly invested, but not enclosed, by the accrescent calyx; seeds flattened, reniform, rugose-reticulate, browning with maturity; $x = 12$.

KEY TO THE SPECIES

a. Leaves 1.5-3.5 cm wide, ovate to broadly ovate-lanceolate, entire to crenate; flowering calyces exceeding 5mm long. . . . . *b.*

b. Herbage villous with long forked and simple trichomes; leaves subsessile, blades ca ½ as wide as long. . . . . 4. *C. villosa.*

b. Herbage basically glandular-pubescent, but with some longer simple trichomes; leaves petiolate, blades ca as wide as long. . . . . 5. *C. crenata.*

a. Leaves less than 2.0 cm wide; flowering calyces usually less than 4 mm long. . . . . *c.*

c. Herbage predominately glabrous or pubescent with branched or stellate hairs; leaves linear, linear-lanceolate, or rhombic, entire irregular, or few-lobed; stems usually purplish or gray at base. . *d.*

d. Leaves linear to linear-lanceolate, usually few-lobed; sparsely pubescent with scurfy, white, stellate or branched hairs. . . . . . *e.*

e. Leaves sparsely pubescent with stellate hairs; pedicels without glandular hairs. . . . . 1. *C. coronopus.*

e. Leaves glabrous; pedicels with glandular hairs. . . . . 2. *C. edwardsiana.*

d. Leaves broadly lanceolate to rhombic, subentire or entire, pubescent with stellate hairs. . . *f.*

f. Leaves densely pubescent with stellate hairs. . . . . 3. *C. pallida.*

f. Leaves glabrous. . . . . 2. *C. edwardsiana.*

c. Herbage predominately glandular-pubescent or glandular-pubescent mixed with simple, longer trichomes; leaves broadly lanceolate or rhombic, entire to pinnately or irregularly lobed; stems green. . . . . *g.*

g. Pubescence of short glandular hairs. . . . . 6. *C. sordida.*

g. Pubescence of trichomes mixed with glandular hairs. . . . . 7. *C. coniodes.*

1. **Chamaesaracha coronopus** (Dunal) Gray, Bot. Calif. 1:540. 1876. Holotype (G!), Mexico, ca Laredo: [Texas, Webb Co. near Laredo] *Berlandier* 1494. Isotypes: not seen. Fig. 2.
Solanum coronopus Dunal, in DC. Prod. 13:54. 1852.
Saracha coronopus (Dunal) Gray, Proc. Amer. Acad. **10**:62. 1874.

Rhizomes slender and subligneous, 1.5-3.5 mm in diameter; stems prostrate or ascending, 10-50 cm long, ca 1.5 mm in diameter, usually purplish or grey below; herbage glabrous to sparsely pubescent with scurfy, short, white stellate hairs; leaves linear to linear-lanceolate, 2.0-6.5 cm long, 1-10 (-15) mm wide, gradually narrowing to an attenuate, subsessile base, apex of blade acute, rounded, or obtuse, midrib prominent, sparsely pubescent with stellate hairs, margin subentire to deeply lobed; flowers 1 or 2 in axils; calyx 2.5-4.0 mm long, rather densely pubescent; corolla 6-10 (-15) mm wide; fruit 4-8 mm in diameter; chromosome number, $n = 12, 24, 36$.

A rather widespread, weedy species occurring throughout most of the range of the genus (Fig. 3). At various

Figure 2. Habit sketch of *Chamaesaracha coronopus*, × 1; A, Leaf, × ca. 1; B, Stem, × 10.

elevations from sea level to 7000 ft., but more frequently in grassland areas with *Larrea, Prosopis,* and *Juniperus,* the species does not seem to be restricted to particular soil types and has even been collected on gypseous soils. Flowering from March to October, primarily in the early and again in the later summer, depending on rains.

Chamaesaracha coronopus is most closely related to *C. edwardsiana.* The plants from south Texas differ somewhat from those found in west Texas, New Mexico, and Arizona in having broader, more lobed leaves. In leaf shape, the plants from south Texas superficially resemble *C. coniodes,* but the two species are not believed to be closely related.

REPRESENTATIVE SPECIMENS: **Arizona:** APACHE CO. Window Rock, 19 Aug 1962. *Bohrer* 737 (UC). COCHISE CO. Ft. Lowell, 31 Jul 1903, *Thomber* 245 (ARIZ, NY, UC). COCONINO CO. Black Point, near Cameron, 18 May 1961, *Demaree* 44084 (ARIZ, SMU, UC). GILA CO. 16 mi S of Safford, 21 Oct 1964, *Gould* 3989 (ARIZ, UC). MOHAVE CO. 5 mi NE of Tweep, *Parker et al.* 6256 (ARIZ, US). NAVAJO CO. Holbrook, 27 Jun 1896, *Zuck s.n.* (GH, NY, US). PIMA CO. Vail, 22 Oct 1926, *Peebles et al.* 3306 (ARIZ, MICH). PINAL CO. near Sacaton, 2 May 1926, *Harrison* 1779 (ARIZ). LAVAPAI CO. near Montezuma Castle Nat'l Monument, 21 May 1936, *Nelson & Nelson* 2050 (GH, NY, UC). YUMA CO. Antelope, May-Oct 1902, *Purpus* 95 (UC).

Colorado: FREEMONT CO. Canyon City, 1872, *Brandegee* 391 (GH, NY, UC, US). LAS ANIMAS CO. 10 mi N of Bronson, 16 Jul 1968, *Averett & Tomb* 348 (SMU, MO, TEX). LINCOLN CO. 7 mi S of Forder School, 6 Jul 1937, *Ownbey* 1327 (GH, NY, UC). PUEBLO CO. mesas near Pueblo, 15 May 1900, *Rydberg & Vreeland* 5666 (NY).

Oklahoma: CIMARRON CO. 3.5 mi N of Kenton, 7 Oct 1950, *Waterfall* 9713 (ARIZ, OKLA, SMU).

New Mexico: BERNALILLO CO. Albuquerque, 4 Sep 1884, *Jones* 4147 (ARIZ, GH, NY, UC, US). COLFAX CO. vicinity of Raton, 21-22 Jun 1911, *Standley* 6365 (US). DONA ANA CO. plains E of Organ mts. 28 Aug 1897, *Wooton* 406 (GH, NY, UC, US). GRANT CO. Mangas Springs, 18 mi NW of Silver City, 31 May 1903, *Metcalfe* 97 (ARIZ, NY, UC, US). HIDALGO CO. 5 mi N of Animas, 9 Sep 1950, *Castetter* 3030 A & B (UNM). LINCOLN CO. above Tularosa, 24 Aug 1897, *Wooton s.n.* (ARIZ, US). LUNA CO. foothills, Tres Hermanas Mts, W of Columbus, 12 Sep 1942, *Clark s.n.* (UNM). MCKINLEY CO. Gallup, 28 Jul 1933, *Degener* 4834 (NY). OTERO CO. White Mts, divide above Mescalero, 1 Aug 1897, *Wooton s.n.* (NY, US). SANDOVAL CO. 19 mi W of Santa Fe on Rio Grande River, 31 May 1897, *Heller & Heller* 3633 (GH,

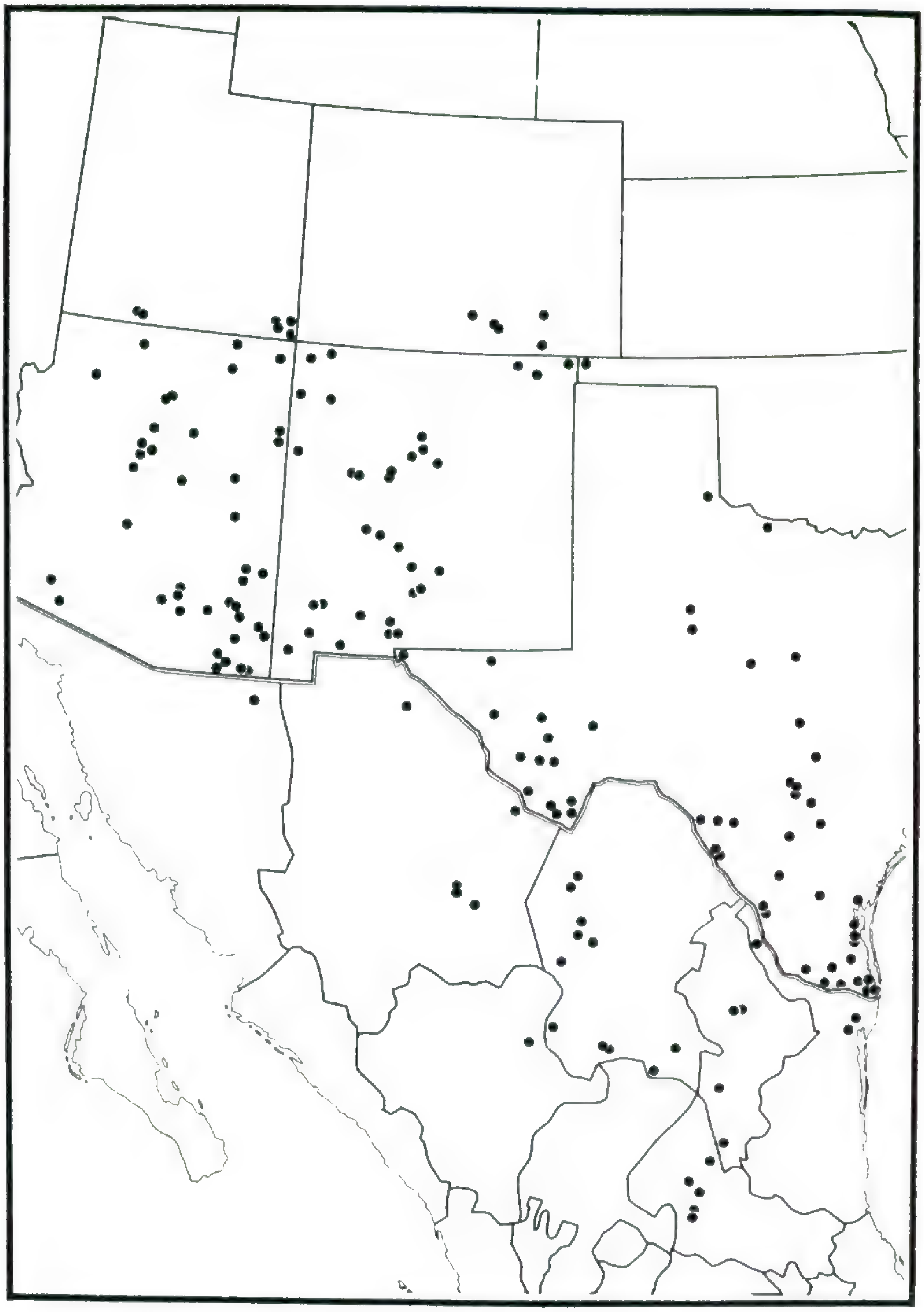


Figure 3. Distribution of *Chamaesaracha coronopus*.

NY, US). SAN JUAN CO. Sheep Springs, 18 Aug 1880, *Rusby* 302 (MICH, NY). SAN MIGUEL CO. near Pecos, 18 Aug 1908, *Standley* (GH, NY, US). SANTA FE CO. S of Santa Fe near hwy 85, 14 Jul 1966, *Plowman* AP195 (ARIZ). SOCORRO CO. Ojo Caliente, 28 Jul 1904, *Wooton* 2683 (US). UNION CO. 2 mi W of Oklahoma line, NW of Kenton, 11 Jun 1948, *Rogers* 5973 (MICH, US). VALENCIA CO. 5 mi W of Correo, 15 Jun 1959, *Martin* 3273 (UNM).

Texas: BEXAR CO. San Antonio, 23 Apr 1917, *Palmer* 11626 (TEX). BREWSTER CO. Alpine, 7 Jun 1940, *Warnock* 21586 (TEX). BROWN CO. Brownwood, 31 Mar 1917, *Palmer* 11439 (TEX). BURNET CO. Marble Falls, 1 Apr 1913, *Young s.n.* (TEX). CAMERON CO. Boca Chica rd, 2 mi E of Palmito battleground monument, 29 Apr 1959, *Travers* 1160 (SMU, TEX). CHILDRESS CO. Spr 1931, *Biology class s.n.* (TEX). CULBERSON CO. railroad near Kent, 1 May 1902, *Tracy & Earle* 407 (NY, TEX, US). DUVAL CO. San Diego, 1885, *Croft* 5994 (US). EL PASO CO. vicinity of El Paso, 1911, *Stearns* 39 (US). ERATH CO. 21 Mar 1921, *Gough s.n.* (TEX). HIDALGO CO. 6 mi E of Sulivan City, 8 Mar 1959, *Turner* 4493 (TEX). JEFF DAVIS CO. 9 mi NE of Ft. Davis in Limpia Canyon, 27 Apr 1947, *Cory* 53554 (SMU). KARNES CO. 0.5 mi NW of Karnes City, 14 Mar 1953, *Johnson* 1140 (SMU, TEX). KLEBERG CO. Kingsville, 11 Apr 1905, *Tracy* 9225 (GH, NY, TEX, US). LA SALLE CO. 10 mi N of Encinal, 30 Mar 1935, *Wiegand* 2065 (GH). MAVERICK CO. on the Rio Grande River, Eagle Passs, 7 Mar 1852, *Schott s.n.* (NY, US). MCKINNEY CO. 1881, *Garrett s.n.* (NY). MITCHELL CO. 5 mi SE of Colorado City, 29 Jul 1945, *Pohl* 5113 (SMU). NUECES CO. Corpus Christi 21 Mar 1907, *York s.n.* (TEX). OLDHAM CO. Tascosa, 16 Jun 1932, *Reed* 3510 (US). PECOS CO. 3 mi N of Ft. Stockton, 22 Jun 1952, *Warnock* 10490 (SMU). PRESIDIO CO. Marfa, Jun 1936, *Hinckley* 658 (ARIZ, GH, SMU, TEX). SAN PATRICIO CO. 8 mi E of Taff, 20 Oct 1951, *Jones* 652 (SMU). SCURRY CO. 26 mi SW of Snyder, 17 Apr 1960, *Waterfall* 15875 (OKLA). STARR CO. 4 mi W of Ft Ringold, *Tharp & York* 51-250 (TEX). TAYLOR CO. 8 mi S of Abilene, 8 Apr 1960, *McCoy* 3727 (OKLA). TRAVIS CO. Austin, 18 Mar 1940, *Warnock* 88 (TEX). UVALDE CO. NW of Uvalde, 3 Apr 1942, *Lundell & Lundell* 10974 (SMU, US). VAL VERDE CO. Del Rio, 7 Dec. 1891, *Plank s.n.* (NY). WEBB CO. Laredo, 1-20 Aug 1879, *Palmer* 920 (GH, NY). WICHITA CO. 215 mi W 1 mi S of Iowa Park, 8 Jun 1960, *Mahler* 1168 (TEX). WILLACY CO. 3 mi S of Raymondville, 6 Nov 1953, *Shinners* 17108 (SMU). WILSON CO. 4 mi S of Stockdale, 25 Mar 1955, *Johnston & McCart* 5082 (TEX).

Utah: KANE CO. 8 mi E of Kanab, 7 Jun 1957, *Anderson* 760 (NY, UC). SAN JUAN CO. along the San Juan River, 20-25 Aug 1911, *Rydberg & Garrett* 9970 (NY, US).

Mexico: CHIHUAHUA, 6 mi S of Camargo, 29 Jun 1937, *Shreve* 8070 (ARIZ, GH, US). COAHUILA, Saltillo and vicinity, 1898, *Palmer* 145 (GH, NY, UC, US). DURANGO, 85 mi NE of Durango, 11 Aug 1959,

Figure 4. Habit sketch of *Chamaesaracha edwardsiana*, × 1.

Waterfall 15399 (OKLA). NUEVO LEON, 16 mi N of Matehuala, 21 Aug 1959, *Waterfall* 15749 (OKLA). SAN LUIS POTOSI, San Luis Potosi, 1879, *Shaffner* 404 (NY, US). SONORA, mesa de las Carreras, W of Colonia Morelos, 15 Sep-4 Oct 1941, *White* 4547 (ARIZ, GH, MICH). TAMAULIPAS, 10 mi S of Nuevo Leon, 26 Feb 1944, *Barkley* 14326 (GH, NY, TEX).

2. **Chamaesaracha edwardsiana** Averett, Sida 5: 48-49. 1972. Holotype (TEX): TEXAS, Travis Co.: ½ mi E of the Pedernales River on hwy 620. 28 Jun 1968. *Averett* 289. Isotypes: GH, MO, SMU. (Fig. 4).

Rhizomes slender and subligneous, 1.5-3.5 (-7) mm in diameter; stems erect or ascending, 7-30 cm long, ca 1.5 mm in diameter, usually purplish or grey below; herbage glabrous to pubescent with stellate hairs, or occasionally with simple and branched trichomes (especially in the upper portions); leaves linear-lanceolate to rhombic, typically undulate, but occasionally few-lobed, 2.5-7.0 cm wide, base attenuate, subsessile to slightly petiolate, midrib prominent, but secondary veination usually present, essentially glabrous; flowers 1 or 2 in axils, flowering pedicel pubescent with trichomes and glandular hairs; calyx 4-5 mm long, pubescent with stellate, branched and simple trichomes; corolla 1.0-1.5 cm wide; fruit 5-8 mm in diameter; chromosome number, $n = 24$.

Primarily on limestone soils in the Edwards Plateau of Texas (Fig. 6). Flowering from March to October, but mostly in the early and late summer, depending on rains.

Chamaesaracha edwardsiana is probably most closely related to *C. coronopus,* differing from the latter in having glabrous, entire leaves. It is also related to *C. pallida,* differing in the narrow, linear-lanceolate, glabrous leaves.

REPRESENTATIVE SPECIMENS: **Texas:** BEXAR CO. near Bracken, 13 Jul 1903, *Groth* 73 (GH, US). BLANCO CO. ca 1 mi W of Johnson City, 5 Apr 1969, *Tomb & Tomb* 386 (TEX). BRAZOS CO. ½ mi from A & M Campus, College Station, 26 Apr 1967, *Lonard* 1899, (TEX). COMAL CO. Comanche Springs, New Braunfels, May, 1850, *Lindheimer* 1938 (ARIZ, GH, NY, SMU, TEX, UC, US). CROCKETT CO. McKenzie's Well, May 188?, *Reverchon* 1569 (NY, SMU, US). EDWARDS CO. Ranch Expt. Sta., 2 Nov 1929, *Cory* 3469 (GH). HAYS CO.

Figure 5. *Chamaesaracha pallida:* A, Habit sketch, × 1; B, Seed, × ca. 5; C, Leaf × 2; D, Stem, × ca. 10; E, Pubescence, × 50.

E of Henly, 20 Apr 1941, *Lundell & Lundell* 10279 (MICH, US). LAMPASAS CO. 8 mi E of Lampasas, 15 Jun 1929, *Wolff* 940 (US). LLANO CO. near Llano, 4 Aug 1931, *Wolff* 3080 (US). KENDALL CO. 5 mi N of Boerne, 10 May 1969, *Averett* 454 (SMU, MO, TEX). KERR CO. Kerville, 19-25 Apr 1894, *Heller* 1647 (ARIZ, GH, MICH, NY, SMU, UC, US). MENARD CO. 5 mi NE of Menard, 3 Jun, 1968, *Shinners* 32274 (SMU). PECOS CO. 15 mi W of Sanderson, 22 Apr 1948, *Whitehouse* 19729 (MICH, NY, OKLA, SMU). TRAVIS CO. Austin, 17 May 1940, *Lundell & Lundell* 8957 (GH, MICH, NY, SMU, UC, US). UVALDE CO. Montell, 15 Oct 1917, *Palmer* 13006 (TEX, UC). WEBB CO. Laredo Junior College Pasture, 14 Apr 1963, *Abrego s.n.* (TEX). WILSON CO. Sutherland Springs, Aug 1879, *Palmer s.n.* (GH). WILLIAMSON CO. SW of Georgetown, 16 May 1942, *Wolcott* 118 (TEX).

Mexico: COAHUILA, Sierra del Pinto, 26 Aug 1940, *Johnston & Muller* 745 (GH, MICH). NUEVO LEON, 10 mi S of Roberto Junction on hwy 56, 22 Jul 1969, *Bierner & Turner* 90 (TEX). SAN LUIS POTOSI, Charcas, Jul-Aug 1934, *Lundell* 5065 & 5065A (ARIZ, MICH, OKLA, TEX, US).

3. **Chamaesaracha pallida** Averett, Sida 5: 48-49. 1972. Holotype (TEX): TEXAS, Presidio Co.: 35 mi SW of Marfa on Pinto Canyon Road. 15 Jul 1966. *Averett* 155. Isotypes: GH, MO, SMU, US. Fig. 5.

Rhizomes slender and subligneous, occasionally woody; stems suberect to ascending, 7-15 (-20) cm long, 1.0-1.5 cm wide (ca ½ the length), narrowly rhombic, broadly lanceolate, or oblanceolate, entire to deeply undulate, apex acute, obtuse, or rounded, base attenuate, subsessile or short-petiolate, pubescent with stellate or branched hairs; flowers 1 or 2 in axils, pedicels slender 1-2 cm long; calyx 3-4 mm long, pubescent; corolla usually 1-1.5 cm wide; fruit 5-7 mm in diameter; chromosome number, $n = 36$.

A rather rare species of Trans-Pecos, Texas and northern Mexico (Figure 6). Flowering from March to October, primarily in the early and late summer depending on rains. The species appears to be mostly confined to limestone soils, although it has been reported from igneous soils.

Chamaesaracha pallida has its closest affinities with *C. edwardsiana,* and to some extent, *C. sordida.* However, a dense stellate pubescence is typically found in *C. pallida.*

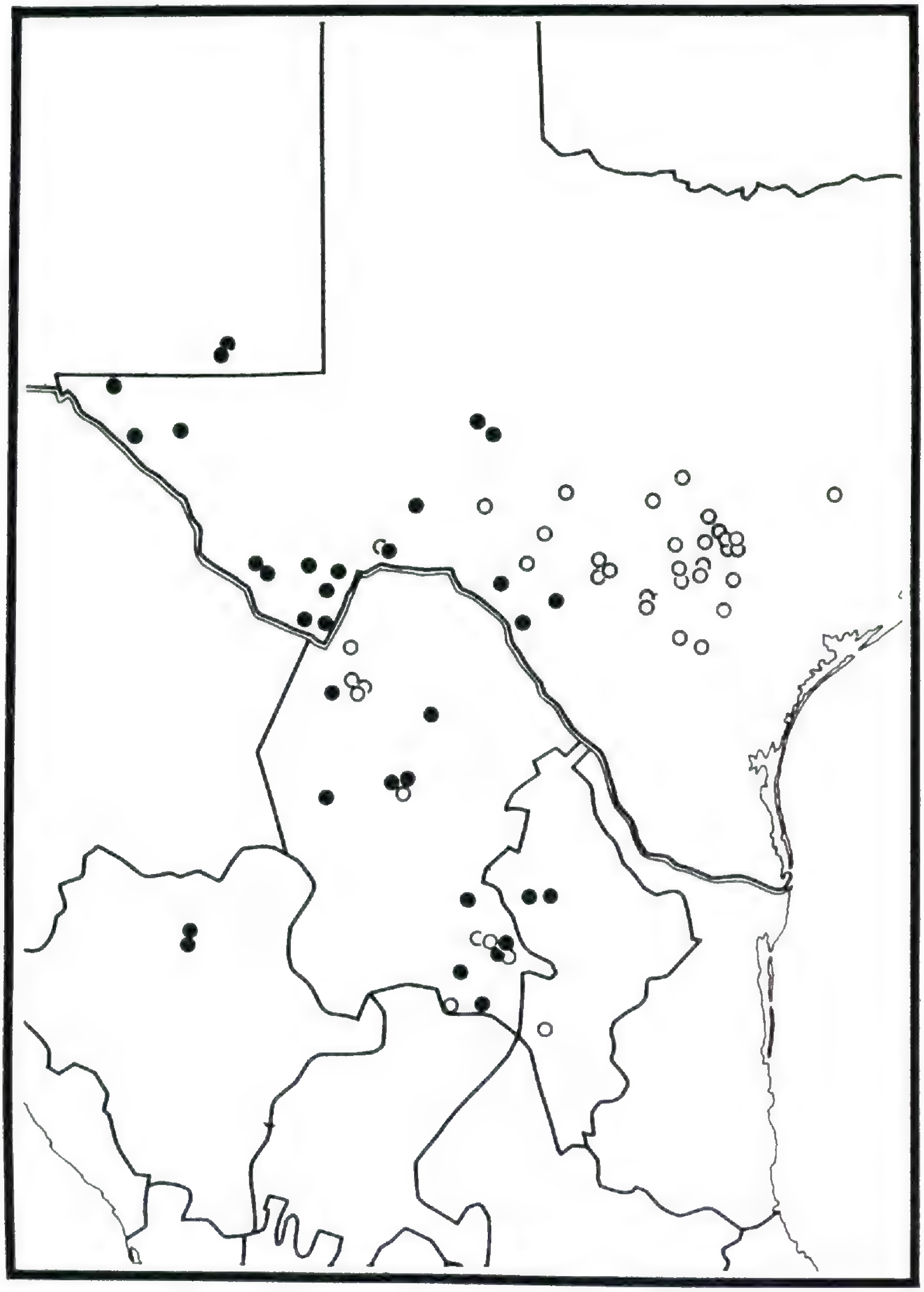


Figure 6. Distribution of *Chamaesaracha edwardsiana* (open circles) and *Chamaesaracha pallida* (closed circles).

Some specimens of *C. edwardsiana* and *C. coronopus* may have considerable pubescence, but not so much as *C. pallida.*

REPRESENTATIVE SPECIMENS: **New Mexico:** EDDY CO. Sitting Bull Falls, 24 May 1944, *Hershey* 3098 (GH).

Texas: BREWSTER CO. 30 mi S of Marathon, 2 Apr 1938, *Warnock* T283 (TEX, US). CULBERSON CO. S of McKittrick Canyon, Guadalupe Mts, 3 Aug 1952, *Warnock* 10941 (SMU). EL PASO CO. Hueco Pass, 29 May 1932, *Whitehouse s.n.* (TEX). HUDSPETH CO. Calcareous Canyon, Malone Mts, 21 Aug 1946, *Waterfall* 6663 (GH, NY). IRION CO. 1 mi S of Mertzon, 24 Apr 1948, *Warnock* 7700 (TEX). KIMBLE CO. 16 Apr 1930, *Wolff* 1601 (US). KINNEY CO. Anacacho Mts, ca 30 mi SE of Brackettville, 15 May 1965, *Strother* 253 (TEX, SMU). PECOS CO. ca 15 mi W of Sanderson, 22 Apr 1948, *Whitehouse* 19729 (SMU). PRESIDIO CO. 3 mi SW of Shafter, 30 Jul 1945, *Muller* 8471 (NY, OKLA, SMU). REGAN CO. 7⅓ mi E of Bit Lake, 24 Apr 1947, *Cory* 53440 (NY, SMU). TERRELL CO. Blackstone Ranch, ca 15 mi S of Sheffield, 15 Jun 1949, *Webster* 269 (MICH, TEX). TOM GREEN CO. 7⅔ mi S of Christoval, 28 Oct 1945, *Cory* 50565 (GH, NY, SMU, UC, US). UVALDE CO. 4 mi E of Kline, 2 Nov 1963, *Moore et al.* 8845 (SMU). VAL VERDE CO. 30 (airline) mi N of Del Rio, 25 Apr 1943, *Cory* 41528 (GH).

Mexico: COAHUILA, 26 mi SW of Monterrey, 1 Dec 1945, *Barkley & Warnock* 14700M (GH, NY, TEX). DURANGO, 9 mi N of La Zarca on hwy 45, *Sikes & Patterson* 398A,B,C, (SMU, SRSC, TEX). NUEVO LEON, Villa de Garcia, 19 Sep 1959, *Fuentes* 19 (OKLA).

4. **Chamaesaracha villosa** Rydb., Mem. Torr. Bot. Club 4: 368. 1896. Holotype (US!), MEXICO, Coahuila: mountains 24 mi NE of Monclova. Sept 1880. *Palmer* 924. Isotypes: GH!, K!, NY!, US!, VT!. Fig. 7.

Plants strongly perennial; rhizomes woody, stems suberect to ascending, 15-50 cm long, 1.5-3.5 mm in diameter, herbaceous to somewhat woody, densely pubescent with long, villous, forked trichomes, occasionally somewhat glandular; leaves 4-7 cm long, 1.5-3.0 cm wide, ovate to ovate-lanceolate, entire to undulate-crenate, apex acute to obtuse, base attenuate, petioles less than ¼ the total length of the leaf if present; flowers 1 to few in axils; pedicels 1-3 cm long; calyx ca 5 mm long, pubescent; corolla 0.5-3.0 cm wide; fruit 5-8 mm in diameter; chromosome number, *n*-12.

Figure 7. *Chamaesaracha villosa:* A, Habit sketch, × 1; B, Leaf, × 1; C, Stem, × 10; D, Pubescence, × 40.

Creosote bush dominated desert areas of northern Mexico (Durango, Chihuahua, and Coahuila) and Trans-Pecos Texas along the Rio Grande River (Fig. 9), usually occurring in sandy or gravelly washes or along the roadside in disturbed areas. Flowering primarily in early spring (March-April) and fall (September-October).

Considerable data indicate that *Chamaesaracha villosa* is most closely related to *C. crenata.* Further discussion of the two species is found following treatment of the latter.

REPRESENTATIVE SPECIMENS: **Texas:** BREWSTER CO. near Comanche Springs between Terlingua and Lajitas, 17 Jul 1937, *Warnock* 20701 (TEX). CULBERSON CO. N of Van Horn, 10 Jun 1905, *Reverchon s.n.* (SMU). HUDSPETH CO. Indian Hot Springs, 20 Apr 1932, *Whitehouse* 8500 (TEX). PRESIDIO CO. 5 mi N of Ruidosa, 26 May 1964, *Scudday* 372 (OKLA, SRSC).

Mexico: CHIHUAHUA, 31 mi N of Jimenez, 1 Aug 1939, *White* 2171 (ARIZ, GH, MICH). COAHUILA, Mohano, Jun 1910, *Purpus* 4550 (GH, UC, US). DURANGO, 2 mi W of Bermejillo, 18 Sep 1938, *Shreve* 8783 (ARIZ, MICH, UC).

5. **Chamaesaracha crenata** Rydb., Mem. Torr, Bot. Club 4: 368. 1896. Holotype (US!), MEXICO, Coahuila: Parras, 111 mi W of Saltillo. Jun 1880. *Palmer* 923. Isotypes GH!, K!, NY!, US!, VT!. Fig. 8.

Plants strongly perennial; rhizomes woody; stems 15-40 cm long, 1.5-3.5 mm in diameter, herbaceous or somewhat woody, much branched, densely pubescent with glandular hairs mixed with longer trichomes; leaves 4-6 cm long, 1.5-3.5 cm wide, ovate to broadly rhombic, entire-undulate to crenate, apex obtuse, base cuneate or somewhat attenuate; petioles 2-3 cm long (ca 1/3 the total length of the leaf); flowers 1-5 in axils: pedicels 1-3 cm long; calyx (3-) 5-7 mm long, densely pubescent, primarily with long trichomes; corolla 1-2 cm wide; fruit 8-10 mm in diameter; chromosome number, $n = 12$.

Creosote-desert shrub areas of northern Mexico and along the Rio Grande River in Texas (Fig. 9). Usually found in sandy or gravelly washes or along the roadside in

Figure 8. *Chamaesaracha crenata:* A, Habit sketch, × 1; B, Stem × 10; C, Pubescence, × 40.

disturbed areas. Flowering primarily in early spring and in the fall, depending on rains.

Chamaesaracha crenata is most closely related to *C. villosa*. The two species are largely allopatric, but their ranges overlap in Coahuila and in the Trans-Pecos area of Texas (Figure 9). In the latter area, particularly in Big Bend National Park and around Lajitas (Brewster and Presidio Co), the two species are often difficult to distinguish and hybridization is suspected. At the extremities of their ranges, however, the two species are fairly clear and they can be distinguished by the characters given in the key to the species.

Rydberg, in distinguishing the two species, used differences in flower size, fruit size, seed number, and calyx shape. The type specimens do exhibit such differences; however, they are not particularly useful in distinguishing between the taxa since these characters are quite variable both within and among populations.

I have maintained the species as distinct for biological reasons although it might be equally sound to treat the taxa as varieties of but a single species. The characters that distinguish the two are largely of the same kind that distinguish other species in the genus (viz., leaf shape and pubescence), although, perhaps because of gene exchange in regions of overlap, the differences are often not so easily seen. The decision for varietal or specific status is somewhat arbitrary in this instance, so I have chosen to follow Rydberg's treatment in recognizing allopatric species showing minimal gene exchange in regions of sympatry.

REPRESENTATIVE SPECIMENS: **Texas:** BREWSTER CO. Glenn Springs, Big Bend Nat'l Park, 25 May 1955, *Warnock & Wallmo* 12300 (SRSC, TEX). STARR CO. 3 mi N of Roma, 31 Jan 1954, *Shinners* 17714 (SMU). TERRELL CO. Feodora, 26 Apr 1928, *Palmer* 33582 (GH, NY, US). VAL VERDE CO. Shumla, 10 Oct 1936, *Tharp, s.n.* (GH, NY, SMU, UC, US). WEBB CO. Laredo, 15 Mar 1917, *Palmer* 11285 (UC).
Mexico: CHIHUAHUA, 5 km W of Santa Fe, 15 Sep 1942, *Stewart* 2604 (GH). COAHUILA, Parras, Mar 1905, *Purpus* 1081 (GH, NY, UC).

6. *Chamaesaracha sordida* (Dunal) Gray, Syn. Fl. N.

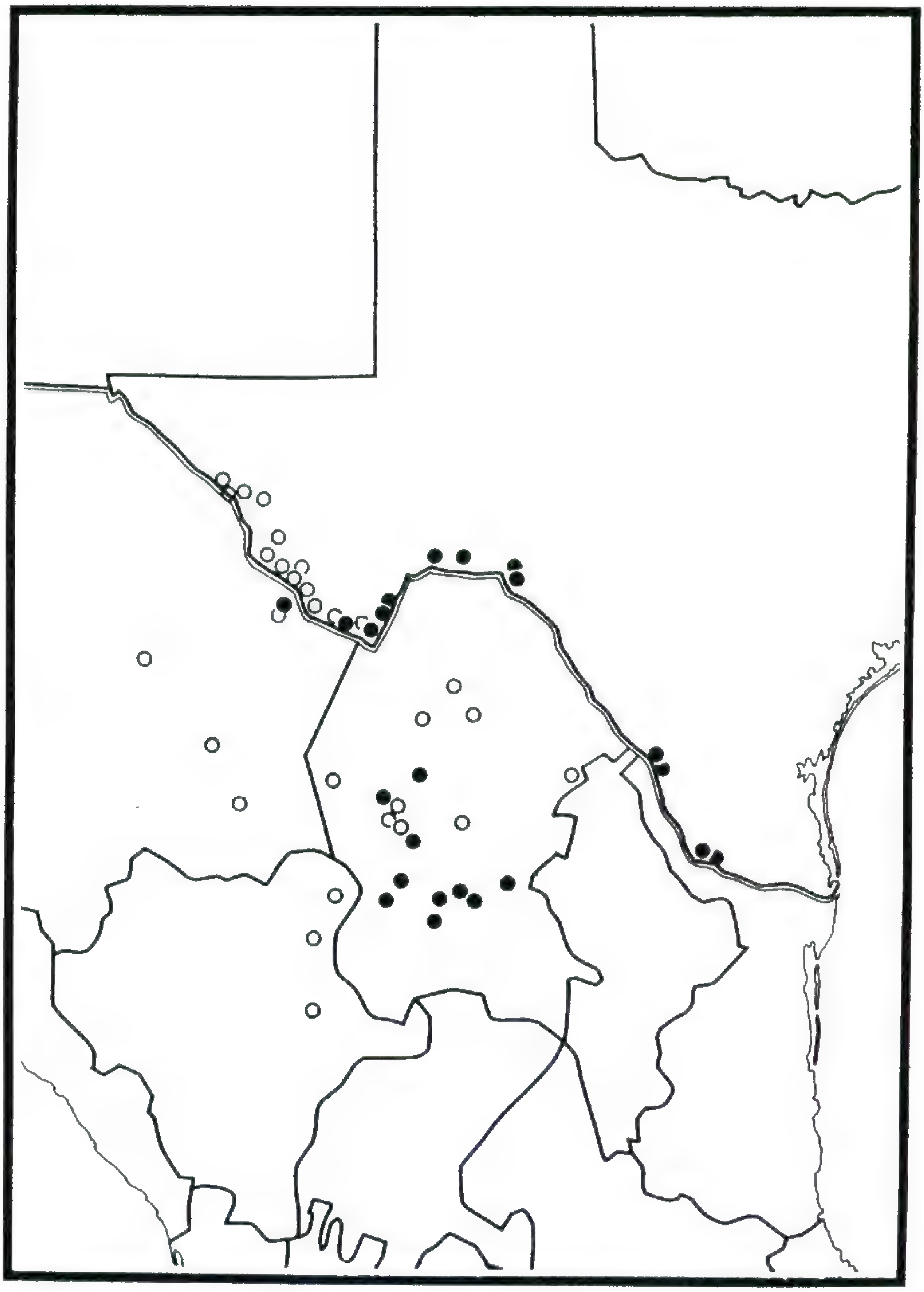


Figure 9. Distribution of *Chamaesaracha villosa* (open circles) and *Chamaesaracha crenata* (closed circles).

Amer. 1: 232. 1876. Holotype (G!), tracing (GH!): TEXAS: Webb Co. near Laredo, Aug 1829. *Berlandier* 2076 (=666). Isotypes: GH!, NY(2)!. Fig. 10.
Withania sordida Dunal. in D.C. Prod. 13: 456. 1852.

Rhizomes subligneous to woody; stems suberect to ascending, 9-30 cm long (typically ca 15 cm), 1.5-2.0 mm in diameter, pubescent, herbage densely glandular pubescent, occasionally mixed with simple trichomes; leaves rhombic, entire or subentire to only slightly lobed, 1.5-4.0 cm long, 4-8 (-10) mm wide, acute to somewhat rounded at the apex, gradually narrowing to a subsessile base; flowers 1-2 in axils; pedicels 1.5-3.0 cm long; calyx ca 3 mm long, rather densely pubescent; corolla typically 1 cm or less wide; fruit 4-8 mm in diameter.

Southwestern United States and adjacent Mexico (Figure 11). Fairly widespread in this area, commonly occurring in disturbed soils along the roadside. Usually in association with *Prosopis* or *Larrea*. Principal flowering dates from March to June and August to October, depending on rains.

Chamaesaracha sordida is related to *C. pallida* and *C. coniodes,* probably more closely to the former. Further consideration of this species is found in the discussion of *C. coniodes.*

REPRESENTATIVE SPECIMENS: **Arizona:** COCHISE CO. 6 mi NW of Chiricahua, 18 May 1945, *Gould & Pultz* 3157 (ARIZ, GH, NY, UC, US). PIMA CO. 26 mi E of Tucson, 10 May 1935, *Maguire* 11214 (GH, NY). PINAL CO. 4 mi N of Christmas, *Anderson et al.* 1047 (ARIZ).

New Mexico: DE BACA CO. 7 mi W of Ft. Sumner, hwy 60, 15 Jun 1961, *Mahler* 1814 (OKLA). DONA ANA CO. Organ Mts, 15 Jul 1897, *Wooton* 156 (GH, NY, UC, US). EDDY CO. Carlsbad Caverns 24 May 1931, *Nelson* 11403 (GH, US). GRANT CO. 3 mi E of Red Rock, 20 May 1935, *Maguire et al.;* R 14. W., 12 Aug 1954, *Gordon & Buchanan* 74 (UNM). LEA CO. 5 mi NW of Hobbs, 7 Apr 1967, *Pearce* 2666 (ARIZ). LINCOLN CO. 5 mi W of Lincoln, 26 Jul 1938, *Hitchcock et al.* 4277 (UC). OTERO CO. Road to Rinconado, 15 Aug 1938, *Humphrey* 57 (ARIZ, UNM). SIERRA CO. Kingston, 10 Sep 1904, *Metcalfe* 1335 (GH, NY, UC, UNM, US). SOCORRO CO. 6.5 mi N of Old Bingham, and 2 mi E, 1 Aug 1949, *Dunn* 6067 (SMU).

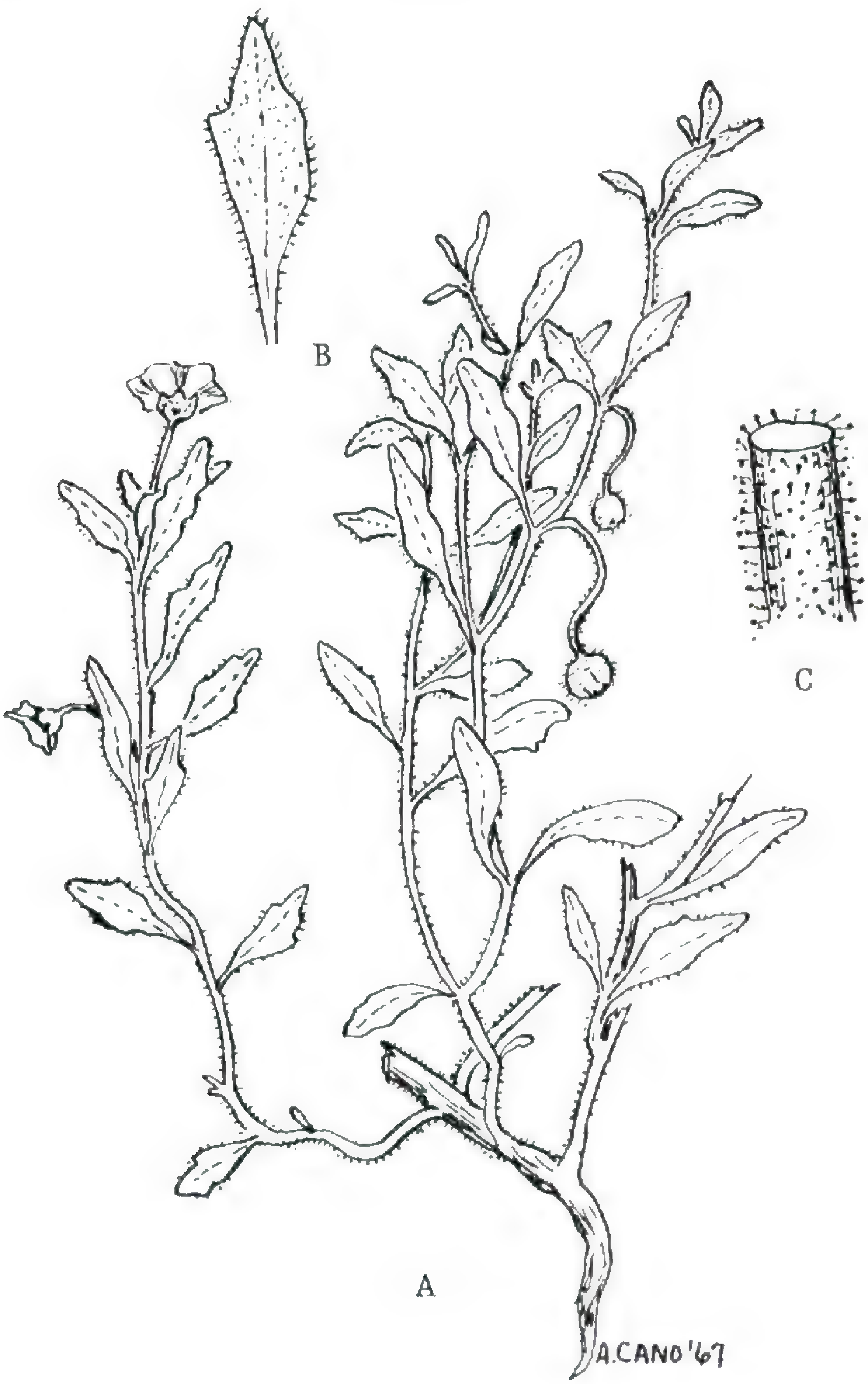


Figure 10. *Chamaesaracha sordida:* A, Habit sketch, × 1; B, Leaf, × 2; C, Stem, × 10.

Texas: BREWSTER CO. foothills of Chisos Mts, 19 Jun 1931, *Tharp s.n.* (GH, MICH, TEX, UC). BRISCOE CO. caprock W of Quitaque on Silverton road, 18 Jun 1945, *Whitehouse* 10001 (SMU). CRANE CO. 6 mi S of Crane, 11 Jul 1941, *Tharp s.n.* (GH, SMU). CROCKETT CO. roadside park over Pecos River Canyon, 26 Sep 1964, *Turner* 5109 (TEX). CULBERSON CO. below McKittrick Canyon, 23 Jul 1931, *Moore & Steyermark* (GH, MICH, NY, UC, US). DAWSON CO. 7 mi SE of Lamesa, 2 May 1967, *Shinners* 31814 (SMU). SIMMITT CO. 3 mi NW of Carrizo Springs, 2 May 1954, *Johnston et al.* 3543 (OKLA, TEX). EL PASO CO. El Paso, 16 Apr 1884 *Jones* 3704 (ARIZ, UC). FLOYD CO. 7 mi S of Floydad, 19 Jun 1964, *Delso* 57 (OKLA). GLASSCOCK CO. 10 mi W of Garden City, 26 Apr 1964, *Turner* 5015 (TEX). HOWARD CO. Scenic Mt, Big Spring, 14 Apr 1963, *Fields* 53 (OKLA). HUDSPETH CO. ca 30 mi E of El Paso, hwy 180, 7 Sep 1955, *Warnock* 13812 (TEX). LOVING CO. ca 10 mi E of Mentone, 3 Jun 1949, *Turner* 966 (SMU). LUBBOCK CO. Buffalo Springs, Lubbock, 29 May 1932, *Reed* 3494 (US). MAVERICK CO. Rio Grande River, Eagle Pass, 7 Mar 1852, *Schott s.n.* (NY). NOLAN CO. oilfield W of Sweetwater, 9 Jul 1941, *Tharp s.n.* (GH, TEX). PECOS CO. Ft. Stockton, 30 Jun 1938, *Warnock* T407 (ARIZ, GH, TEX, US). PRESIDIO CO. ca 20 mi SW of Marfa on Ruidoso road, 24 Jul 1966, *Averett* 153 (SMU, MO, TEX). RANDALL CO. floodplains, Red River, Palo Duro Canyon, 2 Sep 1907, *Ball* 1249 (NY, UC, US). REEVES CO. 25 mi N of Pecos, 4 Aug 1943, *Waterfall* 5491 (GH, NY). SCURRY CO. 12.6 mi E of Snyder, 16 Sep 1966, *Shinners* 31572 (SMU). STARR CO. 10 mi NW of Roma, 15 Mar 1964, *Pena* 21 (SMU). STONEWALL CO. 8.4 mi NW of Aspermont, 29 May 1963, *Shinners* 30036 (SMU). SUTTON CO. 10 mi W of Sonora, 30 Apr 1950, *Cory* 50054 (SMU). TAYLOR CO. ca 1 mi S of Wylie, 29 Mar 1963, *Henderson* 63-102 (SMU, TEX). TERRELL CO. 2-10 mi N of Sanderson, 1 Jun 1957, *Warnock & McBryde* 14868 (TEX). TOM GREEN CO. San Angelo, 18-19 May 1920, *Pennell* 10497 (NY). UPTON CO. 14 mi N of Rankin, 18 Apr 1933, *Cory* 5589 (GH). VAL VERDE CO. 5 mi NE of Juno, 7 Jun 1957, *Warnock & McBryde* 15078 (TEX). WEBB CO. 11 mi S of Laredo, 23 Mar 1963, *Robles* 16 (SMU). WINKLER CO. 10 mi N of Kermit, 8 Dec 1965, *Collins* 1088 (SMU). ZAPATA CO. 22 mi S of Laredo, 4 Apr 1965, *Guerra et al.* 609 (ARIZ, TEX).

Mexico: CHIHUAHUA, 3.5 mi S of Trincheras, 10-12 Aug 1941, *Johnston* 8061 (GH). COAHUILA, Muzquiz, Apr 1938, *Marsh* 1179 (OKLA, SMU, TEX). NUEVO LEON, 23 mi N of Sabinas Hidalgo, 26 Mar 1944, *Webster & Barkley* 14580 (NY, TEX, UC).

7. **Chamaesaracha coniodes** (Moric. ex Dunal) Britt., Mem. Torr. Bot. Club 5: 287. 1895. Lectotype (G) not seen: MEXICO: Canada Verde, between Lardo and Bexar [San Antonio], [TEXAS: McMullen Co] Mar 1828.

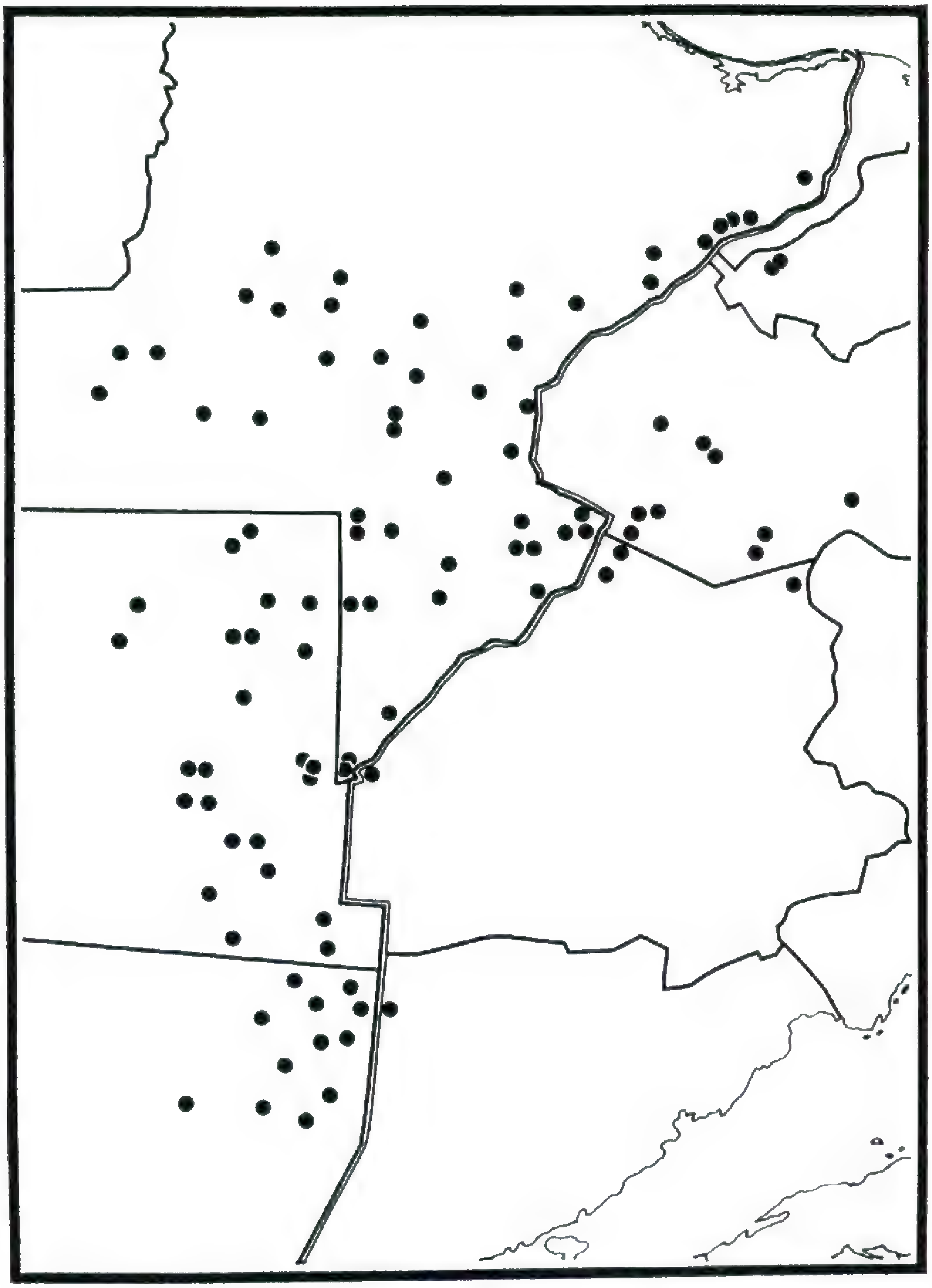


Figure 11. Distribution of *Chamaesaracha sordida*.

Berlandier 1494 (=234). Isotype GH! *Berlandier* 1463 (=203) was also cited in the original description, but I have selected the other collection since the specimen at GH is the only one I have seen. Fig. 12.

Solanum coniodes Moric. ex Dunal, in D.C. Prod. 13(1): 456. 1852.

Rhizomes subligneous to woody; stems prostrate or ascending, 9-30 cm long, 2.0-3.0 mm in diameter, pubescent; herbage pubescent with simple trichomes, occasionally mixed with fewer glandular hairs, usually somewhat villous; leaves broadly lanceolate, 2.5-5.5 cm long, 1.0-2.0 cm wide, crenate to deeply and pinnately lobed; apex acute to rounded, base attenuate, subsessile; flowers 1-2 in axils; pedicel 2.0-3.5 cm long; calyx ca 4.0 mm high; corolla 1.0-1.5 cm wide; fruit ca 7 mm in diameter, chromosome number, $n = 24, 36$.

Southwestern United States and adjacent Mexico (Figure 13). Fairly widespread, commonly occurring in disturbed soils along the roadside, usually in association with *Prosopis* or *Larrea*. Principal flowering dates, March to June and August to October, depending on rains.

Chamaesaracha coniodes was merged with *C. sordida* by Gray (1876). However, the two species may be distinguished by the characters given in the key to the species. Chemical and chromosomal differences also serve to distinguish the two species. In areas of sympatry both taxa retain their diagnostic features, even in mixed populations and, hence, appear to be good biological species.

REPRESENTATIVE SPECIES: **Colorado:** BACA CO. breaks of Carrizo Creek, 5 mi SW of Kirkwell, 29 Aug 1949, *Weber* 5120 (SMU, UC). LAS ANIMAS CO. Tecolate mesa, near Troy, 15 Jul 1947, *Rogers* 4848 (MICH, UC).

Kansas: CLARK CO. 9 mi N of Ashland, 28 Apr 1939, *Horr* E249 (OKLA, SMU, TEX, UC, US). ELLIS CO. Smoky Hill River, 22 Jun 1935, *Bondy* 121 (ARIZ, OKLA, US). FINLEY CO. 4 mi W of Kalvesta, 2 Jun 1967, *Stephens* 11300 (OKLA, SMU, UC). HAMILTON CO. Syracuse, 5 Jul 1893, (OKLA, SMU, UC); Syracuse, 5 Jul 1893, *Thompson* 190 (NY, UC). MORTON CO. 9 mi N, 3 mi W of Elkhart, 7 Jun 1961,

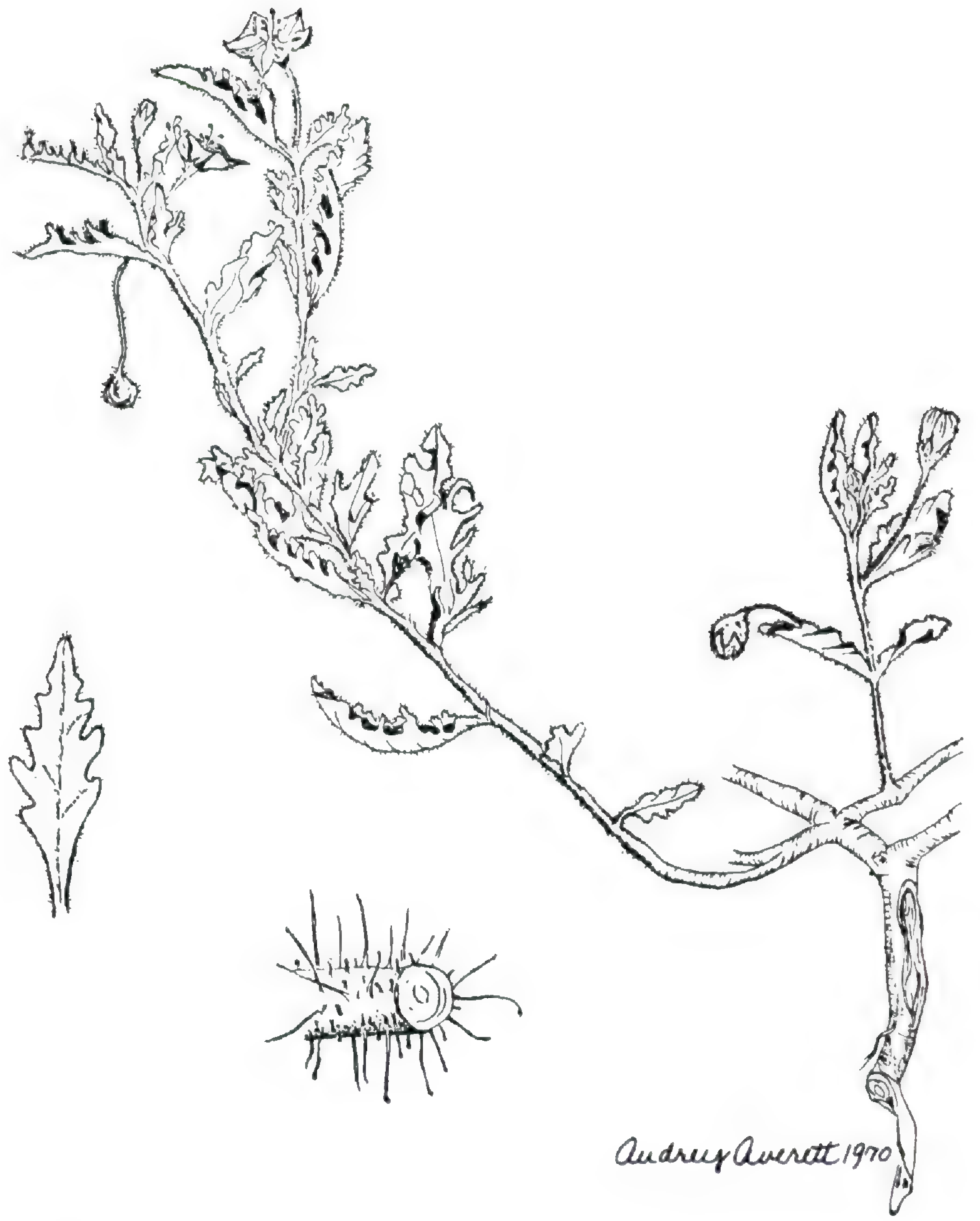


Figure 12. *Chamaesaracha coniodes:* A, Habit sketch, × 1; B, Stem, × 15; C, Leaf, × ca. 1.

Richards 2559 (SMU). SEWARD CO. 12 mi N of Liberal, 8 Jul 1960, *McGregor* 15778 (SMU). ULYSSES GRANT CO. cellar excavations, 26 Jun 1893, *Thompson* 29 (GH, NY, UC, US).

New Mexico: CURRY CO. 5.7 mi W of Melrose, 5 Aug 1945, *Shinners* 20905 (SMU). DE BACA CO. 2 mi N of Ft. Sumner, 3 Jun 1969, *Tomb* 497 (TEX). LINCOLN CO. Gray, 6 Jun 1898, *Skehan* 37 (GH, NY, US). QUAY CO. S of San Juan, 26 Aug 1945, *Waterfall* 6123 (GH, NY, OKLA, SMU). SAN MIGUEL CO. 5 mi SW of Las Vegas, 11 Aug 1949, *Gordon & Norris* 495 (UNM). SIERRA CO. Elephant Butte Dam, 30 Apr 1933, *Nelson s.n.* (UNM). UNION CO. 3 mi W of Oklahoma line W of Kenton, 11 Jun 1948, *Rogers* 5960 (MICH, US).

Oklahoma: BEAVER CO. 2 mi W of Turpin, 16 Aug 1960, *Hindman* 236 (OKLA). BECKHAM CO. 2 mi E of Sayne, 9 Aug 1927, *Stratton* 354 (SMU). CIMARRON CO. 3.5 mi N of Kenton, 7 Oct 1950, *Waterfall* 9714 (ARIZ, OKLA, SMU). CUSTER CO. 1 mi W, 1 mi S of Weatherford, 11 May 1952, *Waterfall* 10716 (OKLA, SMU). ELLIS CO. 3.8 mi S of Shattuck, 25 Sep 1964, *Shinners* 30415 (SMU). GREER CO. near Granite, *Stevens* 1010 (GH, OKLA, US). HARMON CO. floodplain of Elm Fork, 14 mi S of Erick, 25 May 1940, *Waterfall* 2002 (GH, NY, OKLA). JACKSON CO. 6 mi SE of Duke, 29 May 1957, *Waterfall* 13105 (ARIZ, OKLA, US). KIOWA CO. 1.7 mi N of Snyder, 23 Apr 1938, *Fry* 186 (OKLA). MAJOR CO. near Waynoka, 23 May 1913, *Stevens* 599 (GH, NY, OKLA). OKFUSKEE CO. 2 mi E of Paden, 7 Jun 1938, *Ray* 94 (OKLA). SWANSON CO. near Mountain Peak, 23 Jun 1913, *Stevens* 1239 (GH, OKLA). TILLMAN CO. 2 mi S of Frederick, 2 Apr 1961, *Myrick* 49 (OKLA). WOODS CO. 8 mi NW of Alva, 8 May 1932, *Stratton* 3014 (OKLA).

Texas: BAILEY CO. Muleshoe Nat'l Wildlife Refuge, 20 mi S of Muleshoe, 18 Jun 1964, *Rosson* 576 (OKLA, UC). BAYLOR CO. 4.2 mi ENE of Mabelle, 24 Apr 1954, *Shinners* 18584 (SMU). BELL CO. near Sparta, 4 May 1931, *Wolff* 2885 (US). BORDEN CO. red bed lands Colorado to Gail, 25 May 1899, *Bray s.n.* (TEX). BREWSTER CO. hwy 90 12 mi E of Alpine, 8 Sep 1966, *Averett & Watson* 161 (SMU, MO, TEX). BROWN CO. Brownwood, 31 Mar 1917, *Palmer* 11439 (UC). CALLAHAN CO. hwy 183, 4.2 mi S of Baird, 29 Sep 1950, *Cory* 58391 (SMU). CASTRO CO. Nazareth Community, 3 May 1946, *Rachaner* 32 (TEX). CHILDRESS CO. Childress, 21 Apr 1968, *Shinners* 32179 (SMU). COLEMAN CO. 1 mi SE of Santa Anna, 9 Jun 1957, *Shinners* 26386 (SMU). COTTLE CO. S Pease River, 12 mi NE of Paducah, 29 Apr 1963, *Rowell* 8072 (OKLA). COMAL CO. Comanche Springs New Braunfels, etc., Jun 1851, *Lindheimer* 1037 (GH, NY, SMU, TEX, UC, US). COMANCHE CO. 8 mi N of Comanche, 6 Apr 1968, *Seale* 32 (OKLA). DALLAM CO. Rita Blanca Creek, N of Dalhart, Aug 1949, *York & Rodgers* 252 (OKLA, SMU, TEX). DICKENS CO. 2 mi N of Dickens, 28 Jun 1964, *Rowell* 10301 (OKLA). DIMMIT CO. Carrizo Springs, 30 Apr 1930, *Hoaglund s.n.* (TEX). DUVAL CO. 6 mi W of Freer, 20 Mar

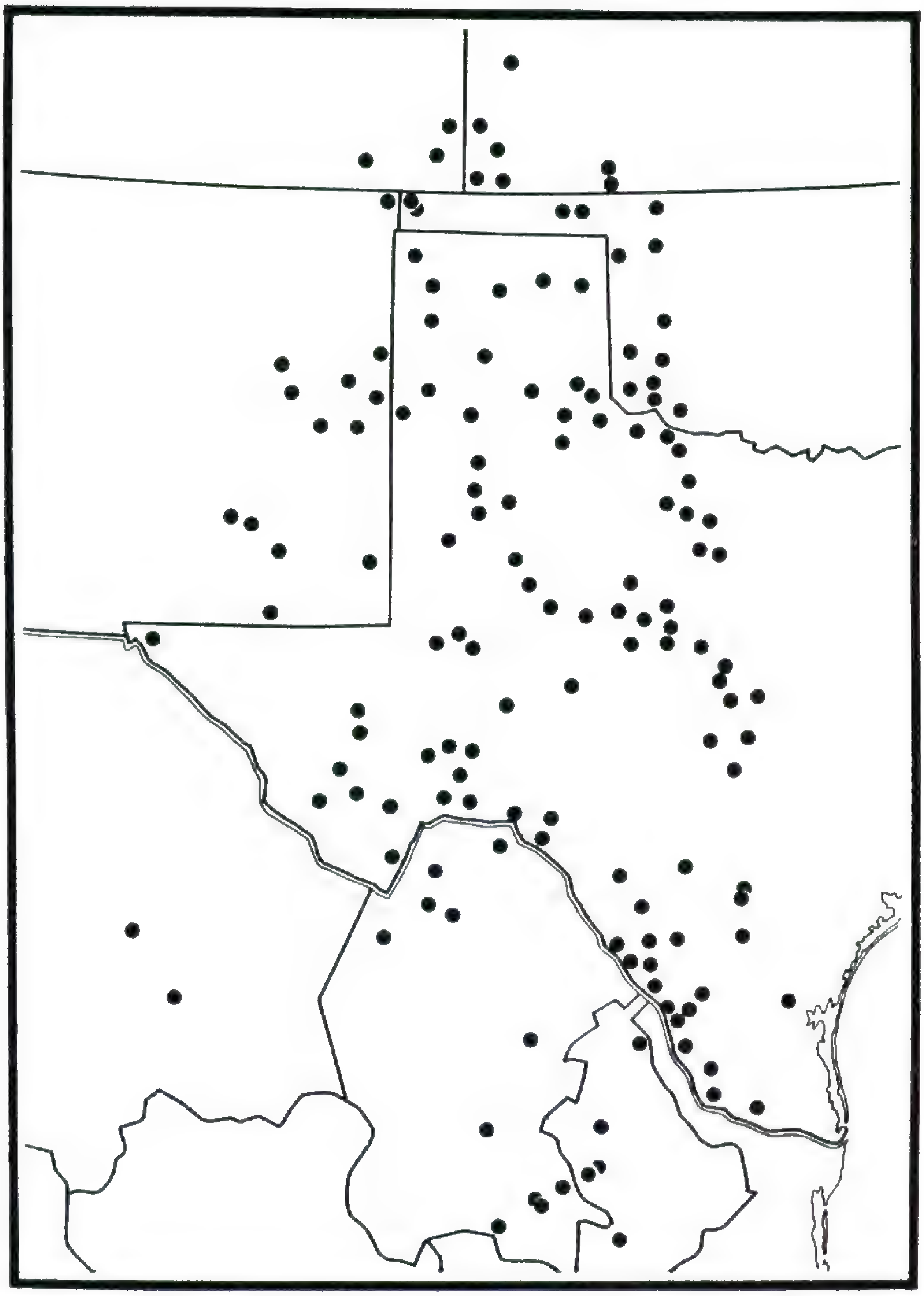


Figure 13. Distribution of *Chamaesaracha coniodes*.

1960, *McCart* 7188 (OKLA). EASTLAND CO. Rising Star, 11 Dec 1931, *Potter s.n.* (TEX). ECTOR CO. NE Odessa, 28 Mar 1967, *Averett* 227 (SMU, MO, TEX). EDWARDS CO. 28 mi W of Rockspring, 18 Apr 1929, *Cory* 689 (GH). EL PASO CO. Loyal Valley (Frontera), 22 May 1852, *Buckley* 7837 (SMU). ERIO CO. hwy 81, 6 mi N of Dilley, 21 Mar 1964, *Vasquez* 50 (SMU, TEX). GARZA CO. Post, 4 Jun 1925, *Ruth* 1270 (MICH, US). HALE CO. 4 mi N of Hale Center, 17 Jul 1968, *Averett & Tomb* 354 (SMU, MO, TEX). HALL CO. *ca* 4 mi from hwy 287, E of Estelline, 6 Sep 1945, *Whitehouse* 10736 (MICH, SMU, US). HAMILTON CO. 5 mi ESE of Hamilton, 14 Apr 1965, *Shinners* 30952 (SMU). HARDEMAN CO. 2 mi W of Quanah, 5 May 1963, *Stokes* 65 (OKLA). HARTLEY CO. junct. of hwy 87 & 385 near Hartley, 16 Jul 1968, *Averett & Tomb* 351 (SMU, MO, TEX). HEMPHILL CO. 7 mi NE of Canadian, 20 Jun 1964, *Brown* 76 (OKLA). HIDALGO CO. 2 mi S of Alamo, 7 Dec 1933, *Clover* 1482 (MICH, NY). HOCKLEY CO. 10 mi E of Levelland, 20 Apr 1964, *Forhand s.n.* (OKLA). HUTCHINSON CO. Canadian River breaks, 4 May 1965, *Drake* 45 (TEX). JACK CO. 3 mi W of Jacksboro, 14 Apr 1946, *Whitehouse* 15308 (SMU). JEFF DAVIS CO. hwy 166, 1 mi S of Ft Davis, 26 Jun 1966, *Averett* 136 (SMU, MO, TEX). JIM HOGG CO. 5 mi E of Hebbronville, 16 Mar 1963, *Areola et al.* 119 (SMU, TEX). LIVE OAK CO. hwy 59, 15 mi SW of George West, 13 Mar 1965, *Rodriquez* 17 (ARIZ, TEX). LUBBOCK CO. ca 5 mi N of Slayton, 17 Jul 1968, *Averett & Tomb* 356 (SMU, MO, TEX). LYNN CO. 11 mi W of Tahoka, 25 Apr 1954, *Shinners* 18621 (SMU). MAVERICK CO. 30 mi SE of Eagle Pass, 14 Mar 1964, *Bruni* 13 (OKLA, SMU, TEX). MC MULLEN CO. 15 mi N of Freer, 28 Apr 1958, *Thompson & Graham* 80 (TEX). MIDLAND CO. 15.6 mi ESE of Midland, 30 May 1963, *Shinners* 30101 (SMU). MILLS CO. 2 mi N of Priddy, 26 Sep 1950, *Cory* 58175 (OKLA, SMU). MOTLEY CO. 3.3 mi W of Matador, 28 Apr 1954, *Shinners* 18693 (SMU). NOLAN CO. Sweetwater, 27 May 1918, *Palmer* 13709 (US). OCHILTREE CO. Canadian River, 27 mi S of Perryton, 19 Sep 1958, *Wallis* 7820 (SMU, TEX). OLDHAM CO. Tascosa, 16 Jun 1932, *Reed* 3515 (US). RANDALL CO. entrance to Palo Duro State Park, 17 Jul 1968, *Averett & Tomb* 353 (SMU, MO, TEX). REEVES CO. S of Pecos, 31 Mar 1942, *Nelson & Nelson* 5004 (GH). ROBERTS CO. Canadian River Valley, 27.5 mi S of Perryton, 6 Jun 1958, *Wallis* 7172 (OKLA, TEX). PALO PINTO CO. 9 mi ENE of Gordon, 6 May 1951, *Shinners* 13230 (SMU). PARKER CO. 16.5 mi SW of Weatherford, Brazos River bottoms, 4 Apr 1948, *Shinners* 9971 (SMU). PECOS CO. 1 mi E of Ft Stockton, 19 Apr 1946, *Warnock* 46151 (TEX, UC). PRESIDIO CO. Spur Ranch, S of Marfa, 10 Aug 1941, *Warnock* 21370 (TEX). SAN PATRICIO CO. near Mathis, 5 Apr 1931, MC KELVEY 1724 (GH, US). SAN SABA CO. 20 mi W of Cherokee, 4 Apr 1966, *Henderson* 8 (TEX). SHACKELFORD CO. ½ mi N of Callahan Co line on hwy 283, 24 Apr 1963, *Henderson* 63-516 (SMU, TEX). STARR CO. 9 mi N of Roma, 13 Apr 1962, *Alvarez et al.* 8043 (TEX).

TAYLOR CO. Camp Barkeley, 25 Oct 1942, *Tolstead* 5779 (NY, SMU). TERRELL CO. 1 mi E of Sanderson, 30 Apr 1949, *Warnock & Turner,* 599 (SMU). TERRY CO. 5 mi E of Brownfield, 25 Apr 1954, *Shinners* 18618 (SMU). THROCKMORTON CO. 8.3 mi E of Throckmorton, 29 Apr 1954, *Shinners* 18806 (SMU). TOM GREEN CO. San Angelo, 3 Jul 1917, *Palmer* 12379 (UC). TRAVIS CO. Onion Creek, near Austin, 17 May 1918, *Young s.n.* (TEX). UVALDE CO. Garner State Park, 5 Apr 1969, *Tomb* 391 (TEX). VAL VERDE CO. E city limits, Del Rio, 5 Apr 1969, *Tomb* 401 (TEX). WEBB CO. Laredo, 15 Mar 1917, *Palmer* 11286 (UC). WICHITA CO. Red River 7.4 mi N of Electra, 30 Mar 1945, *Whitehouse* 9590 (MICH, SMU, US). YOUNG CO. 3 mi W of New Castle, 2 Apr 1938, *McCart* 873 (SMU). ZAPATA CO. 1.5 mi S of San Ygnacio, 31 Jan 1954, *Shinners* 17690 (SMU). ZAVALA CO. near Batesville, 25 Mar 1961, *Stewart* 58 (OKLA).

Mexico: CHIHUAHUA, Mts NW of Chihuahua, 1 Aug 1936, *Le Sueur* 47 (OKLA, TEX UC). COAHUILA, 24 mi W of Cd Acuna, 20 Aug 1966, *Powell et al.* 1412 (SRSC, TEX). NUEVO LEON, 12 mi E of Monterrey, 27 Feb 1944, *Barkley* 14351 (GH, TEX, UC).

EXCLUDED SPECIES

C. potosina Rob. & Greenm.
= **Saracha potosina** (Rob. & Greenm.) Averett

C. boliviensis Dammer
= **Solanum chamaesarachidium** (Dammer) Bitt.

C. grandiflora (Hook.) Fernald
= **Leucophysalis grandiflora** (Hook). Rydb.

C. nana Gray
= **Leucophysalis nana** (Gray) Averett

C. heterophylla Hemsl.
= **Leucophysalis heterophylla** (Hemsl.) Averett

C. japonica Fr. & Sav.
= **Physaliastrum japonicum** (Fr. & Sav.) Honda

C. echinata Yatabe
= **Physaliastrum japonicum** (Fr. & Sav.) Honda

C. savatieri Makino
= **Physaliastrum savatieri** (Makino) Makino

C. watanabei Yatabe
= **Physaliastrum savatieri** (Makino) Makino

C. sinensis Hemsl.
= **Physalis sinensis** (Hemsl.) Averett

C. physaloides Green
= **Physalis labata** Torr. fide Waterfall (1958).

LITERATURE CITED

AVERETT, J. E. 1970. Systematics of *Chamaesaracha* (Solanaceae): A chemosystematic and cytotaxonomic study. Ph.D. Dissertation. University of Texas at Austin.

————. 1971. New Combinations in the Solaneae (Solanaceae) and comments regarding the taxonomy of *Leucophysalis*. Ann. Mo. Bot. Gard. **57**: 380-382.

AVERETT, J. E. & T. J. MABRY. 1971. Flavonoids of the North American Species of *Leucophysalis* (Solanaceae). Phytochemistry **10**: 2199-2200.

AVERETT, J. E. 1972. Two New Species of *Chamaesaracha* (*Solanaceae*) from Texas. Sida **5**: 48-49.

AXELROD, D. I. 1958. Evolution of the Madro-Tertiary Geoflora. Bot. Rev. **24**: 433-509.

FERNALD, M. L. 1949. Contributions from the Gray Herbarium of Harvard University. No. CLXIX. Part II. Studies of Eastern American Plants. Rhodora **51**: 82-83.

GRAY, A. 1876. Synopsis of the North American species of *Physalis*. Proc. Amer. Acad. **10**: 62.

————. 1876. Bot. Calif. 1.540.

————. 1878. Syn. Fl. N. Amer. 2:232.

HOOKER, W. J. 1841. Flora Boreali-American. Vol. 2.

LEWIS, H. 1967. The taxonomic significance of autopolyploidy. Taxon **16**: 267-271.

MABRY, T. J., K. MARKHAM, & M. B. THOMAS. 1971. The systematic identification of Flavonoids. Springer-Verlag, New York.

MAKINO, T. 1914. Observations on the flora of Japan. The Botanical Magazine **28**: 20-22.

POWELL, A. M. & J. AVERETT. 1967. Chromosome numbers of *Chamaesaracha* (*Solanaceae*) in Trans-Pecos Texas and adjacent regions. Sida **3**: 156-162.

RYDBERG, P. A. 1896. The North American species of *Physalis* and related genera. Mem. Torr. Bot. Club **4**: 279-374.

TURNER, B. L. & M. C. JOHNSTON. 1961. Chromosome numbers in the Compositae III. Certain Mexican species. Brittonia **13**: 64-69.

WATERFALL, U. T. 1958. A taxonomic study of the genus *Physalis* in North America north of Mexico. Rhodora **60**: 113-114.

WETTSTEIN, R. 1895. *Solanaceae* in Engler & Prantl, Die Naturlichen Pflanzenfamilien IV (36): 4-39.

DEPT. OF BIOLOGY
UNIVERSITY OF MISSOURI
ST. LOUIS, MO. 63121

Isoëtes melanopoda Gay. and Dur.

ALABAMA. CHEROKEE COUNTY: locally abundant on clay of low flat places in savanna-pasture by Alabama 9, ca. 6 miles south Centerville, 5 June 1969, *Kral* 35013.

Not hitherto recorded for Alabama. According to Pfeiffer (Ann. Mo. Bot. Garden 9: 151-152, 1922) it is extremely close taxonomically to *E. butleri,* and intergrades with it. It has the same ephemeral habit. On the Alabama site, it has collected along with *Schoenolirion croceum, Fimbristylis puberula,* and the very rare *Marshallia mohrii.*

Lycopodium alopecuroides L.

TENNESSEE. COFFEE COUNTY: sandy clay of sphagnous area by pond, by Tennessee 55, ca. 5.2 miles north of Manchester, 7 August, 1970, *Kral* 40215.

This lycopod, here in association with an abundance of *Rhynchospora perplexa,* has previously been collected in Tennessee from Coffee and Fentress counties by Shaver. It is reported by Wherry (Southern Fern Guide: 288, 1964) as abundant, though local, on sandy seepage and in bogs from Florida north to New York and west in the coastal plain into Mississippi. As Wherry states, *L. alopecuroides* and *L. prostratum* Harper are similar enough to be treated by some as varieties of the same species. However the case, my own material shows the arching stems so characteristic of the former and in sharp contrast to the prostrate, rooting habit of the latter. Material agreeing with *L. prostratum* has also been collected from Coffee County, Tennessee, by Shaver.

Sagittaria isoetiformis T. G. Sm.

ALABAMA. COVINGTON COUNTY: sandy shallows of Blue Pond, Blue Springs Wildlife Management Area, Conecuh National Forest, southwest of Andalusia, 1 June 1970, *Kral* 39506. HOUSTON COUNTY: Indigo Pond, 9 June 1971, *Kral* 43119.

Previously reported for Alabama by Dr. Godfrey (Sida **1** [5], 1964), and by others, but still infrequent enough to deserve mention. This species appears only around lime-

sink lakes and ponds, and in Alabama is in association with the same kinds of rarities (namely *Xyris longisepala, Rhexia salicifolia, Eriocaulon lineare, Lachnocaulon minus*) as are found in similar sites in northwest Florida.

Festuca myuros L.

ALABAMA. CHEROKEE COUNTY: sandy empty lot, Centre, 6 June 1969, *Kral* 35039. PICKENS COUNTY: sandy clearing in oak-pine, 1.5 miles north Carrolltown, 5 June 1971, *Kral* 43026.

An extension of known range westward from Georgia or eastward through the gulf south.

Eragrostis amabilis (L.) Wight and Arn. ex Nees.

ALABAMA. ESCAMBIA COUNTY: weed on sandy grounds of Southland Motel, east side of Atmore, 20 October 1969, *Kral* 38071. GENEVA COUNTY: sandy grounds of Eunola Motel, east side of Geneva, 13 October 1970, *Kral* 41737.

In Hitchcock's Manual of the Grasses of the United States, ed. 2 (1950) this grass is not reported for Alabama. It is of frequent occurrence in Georgia and Florida, probably as an introduction from the tropics.

Diarrhena americana Beauv.

Diarina festucoides Raf.

Not previously reported for Alabama, though reported in Hitchcock from Tennessee and the Virginias.

ALABAMA. JACKSON COUNTY: rich limestone woods by upper Paint Rock Creek and Alabama 65, ca. 7 miles north Princeton, 30 September, 1971, *Kral* 44597.

Chasmanthium nitidum (Baldwin in Ell.) Yates

Uniola nitida Baldwin in Ell.

ALABAMA. HOUSTON COUNTY: Cowart's Creek bottoms, rich woods, by Alabama 53, ca. 5 miles southeast Cottonwood, 16 July, 1970, *Kral* 40003.

Reported by Yates (Southwestern Naturalist 11 [4]. 1966) as occurring from South Carolina through south Georgia and Florida, but not reported by him for Alabama.

Spartina spartinae (Trin.) Merr.

ALABAMA. MOBILE COUNTY: on brackish sands by causeway just north of Dauphin Island, 22 September 1969. *Kral* 36368.

This cordgrass occurs in salt marshes along the gulf coast from Florida west to Texas, but no previous reports from Alabama have been made.

Leptochloa fascicularis (Lam.) Gray

ALABAMA. MOBILE COUNTY: Battleship Park, by causeway US 90-98, east of Mobile on the Bay; moist sands, 20 August 1968, *Kral* 32754.

This grass, though previously reported from Mobile County by Mohr (Plant Life of Alabama, 1900) was for some reason not mapped for Alabama in Hitchcock, where it is reported from Mississippi and Florida.

Leptochloa uninervia (Presl.) Hitchcock and Chase

ALABAMA. MOBILE COUNTY: sands of large clearing by Battleship Park, along US 90-98 causeway over Mobile Bay, 16 April, 1967, *Kral* 28449. MORGAN COUNTY: exposed drying silt of Flint Creek bottoms, just south of Flint on US 31, 22 September 1970, *Kral* 41193.

Reported in Hitchcock (*op. cit.*) as from Mexico, north to Oregon in the west; introduced locally in Maine, Massachusetts and New Jersey, also in the coastal plain from Louisiana into Texas.

Chloris floridana (Chapman) Vasey

ALABAMA. COFFEE COUNTY: sandy bluffs above Pea River, 9.5 miles east Opp, 12 October 1970, *Kral* 41678. ESCAMBIA COUNTY: Sandy Conecuh River bottoms 6.0 miles east of Boykin off US 29, 4 October 1971, *Kral* 44832. GENEVA COUNTY: sandy live oak-longleafpine banks of Pea River just west of Samson on Alabama 52, 19 October 1969, *Kral* 38045; sandy field at edge of gum swamp, ca. 7 miles southeast of Samson on Alabama 87, 19 October 1970, *Kral* 38060.

This *Chloris* has previously been found only in Florida and Georgia, essentially along the sandy banks of coastal

plain rivers, very frequently in association with live oak. There are no prior reports of it from Alabama.

Deschampsia flexuosa (L.) Trin.

ALABAMA. BLOUNT COUNTY: mesic woods of N facing bluffs above Mulberry Fork of Warrior River where crossed by US 20, 13 miles south of Cullman, 10 May 1966, *Kral* 26631. JACKSON COUNTY: arenaceous, open outcrops, Flat Rock, 4 June 1969, *Kral* 34944.

Reported by Mohr (*op. cit.*) from Dekalb County in Alabama, but not reported for Alabama in Hitchcock (*op. cit.*). A wide ranging hairgrass, essentially throughout the Appalachians and from the old mountains of Arkansas and Oklahoma. In Alabama and elsewhere it is on arenaceous rock, or the sands derived.

Melica nitens Nutt. ex Scribn.

ALABAMA. FRANKLIN COUNTY: open limestone glade ca. 5 miles south of Russellville, 28 May 1970, *Kral* 39120. BIBB COUNTY: rocky bluffs above Schultz Creek 1.8 miles north of Centreville off Alabama 5, 15 April 1970, *Kral* 38502.

An extension of known range into Alabama from Tennessee and North Carolina. Frequent in the cedar glades of middle Tennessee (Marshall, Maury counties). Appears to have an affinity for calcareous barrens and bluffs. In the Bibb County locality, it is in association with *Croton alabamensis*.

Aristida tuberculosa Nutt.

ALABAMA. GENEVA COUNTY: sandy high banks of Choctawhatchee River between Geneva and Eunola beside Alabama 52, 18 September 1971, *Kral* 44354.

Here reported as new for Alabama, though already reported in Hitchcock (*op. cit.*) for Georgia and Mississippi. A grass of dry sandy areas along the Atlantic and Gulf coasts, also inland in the Great Lakes region.

Muhlenbergia glabriflora Scribn.

TENNESSEE. MAURY COUNTY: banks of Duck

River, rocky bluffs, by I-65, 11.7 miles north northeast Lewisburg, 14 August 1971, *Kral* 43551.

Here reported as new for Tennessee. Similar to *M. frondosa,* differing from it in the scaberulous nodal areas and in the awnless glumes.

Paspalum minus Fourn.

ALABAMA. MOBILE COUNTY: sandy peat at edge of hillside pineland bog, by US 45, 3.8 miles southeast of Chunchula, 3 June 1970, *Kral* 39624; sandy lot, west side of Mobile near junction International Drive and Interstate 10, 2 September 1970, *Kral* 41021.

A species of central America and the West Indies but already reported from eastern Texas. A first record however for Alabama.

Reimarochloa oligostachya (Munro) Hitchcock.

ALABAMA. MOBILE COUNTY: Battleship Park, brackish sands by US 90-98 causeway over Bay, 23 September 1969, *Kral* 37405.

Previously reported only from Florida, Cuba. Superficially similar to *Paspalum vaginatum* Sw.

Brachiaria platyphylla (Griseb.) Nash.

B. extensa Chase

ALABAMA. PICKENS COUNTY: ca. 2.5 miles north of Aliceville; common on sandy clay of banks of Alabama 17, 3 August 1971, *Kral* 48486. WILCOX COUNTY: ca. 4 miles north of Camden on Alabama 41; sandy clay of highway bank, 21 August 1968, *Kral* 32788.

Previously reported for the state but scarce enough in Alabama to be noteworthy. No record of it for Alabama appears in Hitchcock (*op. cit.*).

Setaria faberi Herrm.

ALABAMA. LAWRENCE COUNTY: sandy clearing in oak-pine by Alabama 33, 8.8 miles south of Moulton, 22 September 1970, *Kral* 41250.

A widespread, aggressive weed, rapidly spreading southward into Tennessee and North Carolina, just recently

reported from Georgia, but hitherto not reported for Alabama.

Panicum adspersum Trin.

ALABAMA. COVINGTON COUNTY: sandy road shoulder by Pond Creek, just west of Florala, 29 October 1969, *Kral* 38151.

Frequent on coral rock in southern Florida and showing up at a variety of U.S. ports, including Mobile, as reported by Hitchcock. However, this indication of its establishment so far inland is noteworthy.

Panicum amarum Ell.

ALABAMA. MOBILE COUNTY: sand dunes, Dauphin Island, 3 September 1970, *Kral* 41041.

A species of coastal dunes in Florida and Mississippi, west into Texas; also on similar situations north into New England. Not reported for Alabama by Hitchcock and Chase, though reported from Cedar Point in Mobile County by Mohr.

Panicum linearifolium Scribn.

ALABAMA. LAUDERDALE COUNTY: sandy clay of oak flats by US 43, ca. 0.5 miles west of Green Hill, 4 June 1968, *Kral* 31052.

This entity reportedly intergrades with *P. werneri* Scribn. Whatever the taxonomic status, there are no prior reports of it from Alabama.

Panicum malacophyllum Nash.

ALABAMA. BIBB COUNTY: sandy oak-pine with some longleaf, along Alabama 5, ca. 5 miles south of Braehead, 9 May 1966, *Kral* 26575.

An extension of known range southward from Tennessee.

Panicum webberianum Nash.

ALABAMA. COVINGTON COUNTY: 4.3 miles west of Lockhart by county 4 in sandy bulldozed longleaf pineland, 18 April 1970, *Kral*, 38757.

While reported from Mobile County by Mohr, the species is not credited to Alabama by Hitchcock. The species

is distinctive within the sect. "Lancearia" in its rather broad leafblades together with its papillose fertile lemmas.

Panicum werneri Scribn.

ALABAMA. LAUDERDALE COUNTY: sandy clay of oak flats by US 43, ca. 0.5 miles west of Green Hill, 4 June 1968, *Kral* 31066.

Probably but a form of *P. linearifolium;* in any case not previously reported for Alabama.

Amphicarpon muhlenbergianum (Schult.) Hitchcock.

A. floridanum Chapm.

ALABAMA. COVINGTON COUNTY: upper sandy shores of Open Pond, in Conecuh National Forest, southwest of Andalusia, 5 October 1971, *Kral* 44731.

This genus produces dimorphic fruit, only the underground spikelets seemingly developing viable seeds. A first report for Alabama for the genus; the species was previously known to occur from Florida to South Carolina.

Manisuris tuberculosa Nash

ALABAMA. COVINGTON COUNTY: sandy peat of longleaf pine savanna 9.5 mi. s. Opp, 5 October 1968, *Kral* 33681. GENEVA COUNTY: cypress swamp 5.8 miles south of Hartford, 2 September 1969, *Kral* 36722. HOUSTON COUNTY: sandy peat of longleaf pine flatwoods ca. 1 mile southeast Cottonwood, 12 October 1970, *Kral* 41659.

Close taxonomically to *M. rugosa* (Nutt.) Kuntze, separable only in degree of rugosity of the first glume and in the comparative straightness of its rachis joints, and perhaps therefore but a variant. Previously known only from peninsular Florida.

Andropogon arctatus Chapm.

ALABAMA. COVINGTON COUNTY: sandy savanna, ca. 12 miles south of Andalusia, 3 October 1971, *Kral* 44749.

Reported in Hitchcock as only from Florida; similar to *A. ternarius* but racemes duller, more grayish, and less obscured by shorter hairs.

Andropogon divergens (Hack.) Anderss. ex Hitchcock

ALABAMA. ESCAMBIA COUNTY: pitcher plant bog southwest corner of county, Perdido, 5 October 1971, *Kral* 44892. MOBILE COUNTY: 10.7 miles south Theodore on Alabama 59, wet flatwoods 8 October 1967, *Kral* 29734.

An extension of known range eastward from the low pinelands of Texas and Mississippi.

Andropogon capillipes Nash

ALABAMA. BALDWIN COUNTY: sandy pine flats due east of Orange Beach by Alabama 180, 22 October 1969, *Kral* 38250. GENEVA COUNTY: ca. 5 miles south southeast of Hartford on Alabama 167, sandy savanna, 13 October 1970, *Kral* 41714.

Very distinctive because of its dullish, short racemes, and its highly glaucous foliage. Reported in Small to occur from Florida to Mississippi and North Carolina, but not reported for Alabama by Hitchcock.

Andropogon hirtiflorus (Nees) Kunth

ALABAMA. BALDWIN COUNTY: west junction Alabama 59 and Alabama 180 near Gulf Shores Golf Course, along Alabama 180; sandscrub, 9 October 1967, *Kral* 29851. GENEVA COUNTY: savanna by junction Alabama 153 and county 4, south of Ganer and southwest of Samson, 18 September 1971, *Kral* 44317.

This plant of the pine flatwoods of southern Georgia and of Florida is here recorded as new for Alabama.

Andropogon littoralis Nash

ALABAMA. BALDWIN COUNTY: sandhills, Romar Beach, 22 October 1969, *Kral* 38218. Reported by Hitchcock and Chase as from sandy coasts along the Atlantic and intermittently from the Great Lakes, also from southeastern Texas. However, fairly common on coastal dunes of Baldwin County.

Andropogon niveus Swallen

GEORGIA. LOWNDES COUNTY: ca. 4 miles north of Alapaha on River bottoms, 27 July 1967, *Kral* 28672.

Reported previously only from central Florida.

Andropogon perangustatus Nash

ALABAMA. BALDWIN COUNTY: sandy splash pine flats due east of Orange Beach by Alabama 180, 22 October 1969, *Kral* 38228.

Reported in Hitchcock (*op. cit.*) as from bogs and moist pine woods of Florida and Mississippi but not from Alabama.

Scirpus purshianus Fernald

S. debilis Pursh

ALABAMA. CHEROKEE COUNTY: sandy, coldwater slough by campgrounds, Canyon Mouth State Park, by Little River, 3 September 1971, *Kral* 43817. MISSISSIPPI ITAWAMBA COUNTY: 0.5 miles east of Fulton City limits by US 278; wet clay along pond edge, 28 July 1966, *Kral* 27269.

Previously not reported from either Alabama or Mississippi.

Fuirena pumila Torr.

ALABAMA. COVINGTON COUNTY: sandy moist shores of Open Pond, Conecuh National Forest, southwest of Andalusia, 5 October 1971, *Kral* 44735. TEXAS. HARRIS-LIBERTY COUNTY: sandy shores of Lake Houston where crossed by causeway of county farm road 1960, 2 September 1965, *Kral* 25804.

Seemingly first records for this small, annual *Fuirena* for Alabama and Texas; the species is particularly abundant on moist sandy disturbed situations in the lake areas of Florida but ranges northward throughout the Atlantic coastal plain.

Eleocharis melanocarpa Torr.

ALABAMA. COVINGTON COUNTY: sandy shores of Blue Pond, Blue Springs Management Area, Conecuh National Forest, southwest of Andalusia, 18 April 1970, *Kral* 38728; 1 June 1970, *Kral* 39500.

A first report for Alabama, though already reported from states east and west in the coastal plain.

Eleocharis olivacea Torr.

ALABAMA. BALDWIN COUNTY: almost entirely submersed in swift flowing sandy creek through gum swamp by I-65, 4 miles northeast junction Alabama 59 southwest of Atmore, 19 September 1971, *Kral* 44397. ESCAMBIA COUNTY: seepage slope, west side of Brewton, 4 October 1971, *Kral* 44778.

According to Svenson (Rhodora 31: 231-232, 1929) this species ranges from N. S. to Ontario, southward to Florida, western Pennsylvania, Ohio and Michigan but chiefly on the Atlantic Coastal Plain. This is a first report of it from Alabama. A specimen that is probably this species and gotten from Mobile area is at the Mohr Herbarium but Mohr did not identify it, so did not include it in his Flora. Some authors, the latest being Correll and Johnston (Manual of the Vascular Plants of Texas, p. 274, 1970) place it in the synonymy of *E. flavescens* (Poir.) Urban. It is however distinguishable from *E. flavescens* on the basis of its greenish akenes, the cusp-like prolongation of the tubercle of the akene, and by the blunter, greenish-ribbed spikelet bracts. The Baldwin County material shows a very interesting trailing, lax submersed habit, though material gotten from wet sandy shores is similar to *E. flavescens* superficially.

Eleocharis robbinsii Oakes

ALABAMA. GENEVA COUNTY: shallows of savanna pond, by Alabama 4 ca. 10 miles east of Florala, 2 August 1971, *Kral* 43441.

Previously reported from Florida and Georgia and intermittently northward and westward, but not for Alabama.

Eleocharis tricostata Torr.

ALABAMA. COVINGTON COUNTY: sandy peat of flatwoods by gum bay, 13 miles south Opp, 1 June 1970, *Kral* 39447. GENEVA COUNTY: sandy peat of savanna ditch ca. 3.5 miles west of Geneva, 11 June 1971, *Kral* 43288. HOUSTON COUNTY: sandy bands of Indigo Pond, southeast Cottonwood, 9 June 1971, *Kral* 43125.

A first report for Alabama, though the species is listed from both east and west of Alabama within the coastal plain.

Eleocharis wolfii Gray

ALABAMA. FRANKLIN COUNTY: moist swales in calcareous barrens ca. 5 miles east of Russellville beside Alabama 24, 4 June 1971, *Kral* 42932.

Essentially a northern plant, according to Fernald (Gray's Manual, 8th ed., 1950, p. 253) sporadically in Tennessee, Louisiana. A first report for Alabama.

Bulbostylis capillaris (L.) Clark

Stenophyllus capillaris (L.) Britton

FLORIDA. JACKSON COUNTY: Just south of Florida line north of Malone on Florida 71-Alabama 53; sandy disturbed pocosin edge, 1 August 1971, *Kral* 43420.

A second authentic report of this widespread sedge for Florida, the earliest being made from a Chapman specimen gotten from near Apalachicola.

Fimbristylis perpusilla Harper

GEORGIA. SEMINOLE COUNTY: silty margin of pond in slash pine savanna-pasture beside US 84, ca. 1.5 miles east of Donaldsonville, 1 August 1971, *Kral* 43421.

Noteworthy primarily for its sporadic occurrence even at the same locality. Its history of collection is peculiar. Harper collected the type in 1903 in Sumter County, Georgia, where it was very abundant on the drying margins of a flatwoods pond very similar to the one in Seminole County. He made several trips to the same locality in subsequent years but never again found the plant. My discovery of it in Seminole county in July 1962 turned out to be the second authentic record (*Kral* 15486). The following year Dr. Godfrey visited the Seminole county area and found a few plants (*Godfrey* 63204). However, in spite of several trips to that place made subsequently either by Dr. Godfrey or myself, the plants were not in evidence. Yet in 1971, seven years later, it was again in great abundance in the same locality. As was true in 1962, there were sev-

eral other small ponds in the same area, any of these seeming to have the same conditions for growth, but none actually having the plants. As I stated in my treatment of *Fimbristylis* (Sida 4: 126, 1971), *F. perpusilla* appears to have such a refined niche that conditions for successful germination of its seed are but rarely met. It also becomes evident from this one case that its seed may remain dormant in large quantity for at least 8 years, and with no apparent loss of viability. This is but one of many peculiar examples of the sort of complex niches occupied by aquatic and marsh plants, the study of which should be immensely rewarding to ecologists and biosystematists.

Cyperus dentatus Torr.

ALABAMA. COVINGTON COUNTY: shallow water at sandy edge of Open Pond, Conecuh National Forest, southwest of Andalusia, 3 October 1971, *Kral* 44736.

This sedge is essentially northern, in the Atlantic coastal plain occurring south into South Carolina. Mohr (*loc. cit.*, p. 391) reported it from Mobile County as an adventive from the northern states, but subsequent workers have not cited it from Alabama.

Cyperus difformis L.

ALABAMA. LIMESTONE COUNTY: abundant on alluvial flats, bottoms of Tennessee River, north of Dekatur, Wheeler National Wildlife Refuge, 22 September 1970, *Kral* 41221.

A sedge of the Old World tropics reported by Gleason and Cronquist (Manual of Vascular Plants, p. 125, 1963) as adventive in southeastern Virginia; reported from Louisiana (*Delahoussaye* 71) and from California, but a first record for Alabama.

Dichromena colorata (L.) Hitchcock

ALABAMA. BIBB COUNTY: swale beside dolomite outcrop, also in pockets of dolomite, by Alabama 5, 3.6 miles north of Centerville, 29 May 1970, *Kral* 39316.

Noteworthy because of its occurrence so far from the present coast, evidence to the fact that some coastal plain

species still persist along a geologically very old coast. This species is ordinarily not found in Alabama save in the very coastal counties (Mobile, *Baldwin*) and there is confined usually to the inland sides of brackish marsh areas. The only other species in my area is *D. latifolia*, a species of more acid situations inland in the lower coastal plain, but with one very interesting disjunction into Tennessee (A. Gattinger, Flora of Tennessee, 1900).

Rhynchospora fernaldii Gale

ALABAMA. BALDWIN COUNTY: sandy peat of swale in sand pine hills, Romar Beach, 22 October 1970, *Kral* 38192.

Already reported from Alabama (*Buckley* 35) but with no definite locality by Shirley Gale (Rhodora **46**: 1944). Here reported simply to establish a definite locality. The species is essentially in Florida.

Rhynochospora pleiantha (Kuk.) Gale

ALABAMA. COVINGTON COUNTY: sandy beaches, Blue Pond, by recreation area, Blue Springs Wildlife Management area, Conecuh National Forest, southwest of Andalusia, 1 June 1970, *Kral* 39499.

Reported by Gale (*loc. cit.*) as from southeast North Carolina south to Florida and Cuba but not by her from Alabama.

Carex communis Bailey

TENNESSEE. DAVIDSON COUNTY: 7.6 miles northeast junction Tennessee 12 along Little Marrowbone Creek; shaley bluffs, 16 May 1971, *Kral* 42602.

Already reported from east Tennessee by Sharp *et al.* (Preliminary Checklist of Monocots in Tennessee, 1960) but a first report from middle Tennessee.

Carex austro-caroliniana Bailey

ALABAMA. JACKSON COUNTY: shaded sandy loam of Pisgah Gorge, south side of Pisgah, 24 April 1969, *Kral* 34406.

A first report for Alabama of this southern Appalachian *Carex*.

Carex microdonta Torr.

ALABAMA. WILCOX COUNTY: chald prairie ca. 2.5 miles north of Furman, 15 April 1970, *Kral* 38542. TENNESSEE. WILSON COUNTY: Cedars of Lebanon State Park, west of US 231, 15 miles north of Murphreesboro, *J. Baskin* and *C. Caudle* 230.

An extension of known range eastward from Mississippi and probably including material of *C. crawei* Dewey reported from Alabama and Tennessee. A plant of calcareous prairies, hence probably much more common in the limestone or chalk openings of these two states than present collection records indicate.

Carex tenax Chapman

C. validior Mackenzie

ALABAMA. AUTAUGA CO.: sandy longleaf pineland by US 82, 21.5 mi. n.w. Prattville above Little Mulberry Creek, 30 May 1970, *Kral* 39365. CHOCTAW COUNTY: longleaf pine sand hills by Alabama 17, 4.6 miles south of Butler, 4 June 1970, *Kral* 39660. ESCAMBIA COUNTY: sandy longleaf pineland by US 29, ca. 7 miles east of Brewton, 7 June 1968, *Kral* 31253. HOUSTON COUNTY: sandhills above Little Choctawhatchee River by Alabama 92, 1.7 miles west junction US 84, 9 June 1971, *Kral* 43151.

This *Carex*, in section "Triquetrae", which is comprised of but two species, is here listed tentatively as a record for Alabama. The other species of the complex, *C. dasycarpa* Muhl, is in Alabama, but in very different situations, namely moister sands of the beech-magnolia forests.

Xyris difformis Chapman var. *floridana* Kral

ALABAMA. HOUSTON COUNTY: sandy peat of low place in savanna, southeast side of Cottonwood, 16 July 1970, *Kral* 39993.

A first report of this variety from Alabama, though it is known to range west to Louisiana and north in the Atlantic coastal plain to North Carolina.

Xyris fimbriata Ell.

TENNESSEE. COFFEE COUNTY: peaty shores and

shallows of Goose Pond, just east of Arnold Center, 17 August 1970, *Kral* 40682.

This is probably a record station inland for *X. fimbriata*, though it does get out of the coastal plain in Georgia and Alabama. A definite first record for Tennessee. In this particular location growing mixed with *Xyris iridifolia* and *Lachnanthes caroliniana*.

Xyris jupicai Ell.

TENNESSEE. PUTNAM COUNTY: boggy places in hardwood bottom, 6.9 miles south of Cookeville on Tennessee 42, 14 August 1970, *Kral* 40589.

A first record for Tennessee, probably an extension northward from northern Alabama. Primarily a wetlands weed of the coastal plain, Florida north to New Jersey and west to Texas. Widespread in the tropics of the New World.

Xyris longisepala Kral

ALABAMA. COVINGTON COUNTY: sandy shores and shallows of Blue Pond, Blue Springs Wildlife Management Area, Conecuh National Forest, southwest of Andalusia, 31 August 1970, *Kral* 40935.

A first Alabama record for this rare endemic, previously thought (Sida 2: 246, 1966) to occur only in northwest Florida. Very similar to *X. smalliana*, and at this locality mixed with it, but with distinctively different seed character and blooming earlier in the day.

Xyris platylepis Chapman

TEXAS. JASPER COUNTY: 9 miles south of Brookeland on US 96; seepage area in longleaf pineland, 28 August 1967, *Kral* 29058.

Probably the first authentic record from Texas of this species whose range previously was known to extend from Florida north to Virginia, and west into Louisiana (adventive in Hawaii).

Eriocaulon lineare Small

ALABAMA. BALDWIN COUNTY: peaty edge of hypericum pond just north junction I-10 on Alabama 59 and

6 miles south of Stapleton, 8 June 1971, *Kral* 43805. COVINGTON COUNTY: wet sands and shallows of north shore Lake Jackson, Florala, 3 September 1969, *Kral* 36821; sandy beaches, Blue Pond, southwest of Andalusia, 1 June 1970, *Kral* 39494. HOUSTON COUNTY: Indigo Pond, southeast Cottonwood, 9 June 1971, *Kral* 43124.

This species, while already reported for Alabama by Harper, is rare there. It is part of a group of species that frequents sandy shores of sinkhole lakes and ponds, in contrast to its nearest relative taxonomically, *E. texense*, which frequents acid pineland bogs from Texas to Georgia and which has usually died back by the time *E. lineare* comes into bloom and seed.

Lachnocaulon digynum Korn.

ALABAMA. CONECUH COUNTY: sandy longleaf pineland bog 3 miles west of Castleberry, 1 September 1970, *Kral* 40960. ESCAMBIA COUNTY: 1.3 miles east Wawbeek on US 31; sphagnous swale in longleaf pine sandhills, 7 October 1968, *Kral* 33835. MOBILE COUNTY: pine flatwoods bog between Fowl River and Delchamps on co. 59, 15 July 1969, *Kral* 35642. WASHINGTON COUNTY: boggy bottom on county 28, ca. 4 miles southwest of St. Stephens 14 July 1969, *Kral* 35556.

This diminutive species, while already reported for Alabama by Moldenke (Eriocaulaceae. N. Amer. **19** (1), 1937) is scarce enough in that state to be noteworthy. It ranges in the lower terraces of the coastal plain from Florida west to southern Mississippi, but is nowhere abundant.

Lachnocaulon engleri Ruhl.

ALABAMA. BALDWIN COUNTY: peaty swale in slash pine-sand pine woods near estuary, Gulf Shores, 19 August 1968, *Kral* 32646.

This species was until now known only for Florida, where it is locally abundant on sandy lakeshores, particularly in areas of karst topography.

Lachnocaulon minus (Chapman) Small

ALABAMA. COVINGTON COUNTY: sandy shores of Blue Pond, southwest of Andalusia in Conecuh National Forest, 1 June 1970, *Kral* 39503. HOUSTON COUNTY: sandy edges of Indigo Pond, southeast of Cottonwood, 9 June 1971, *Kral* 43120.

A first report for Alabama for this species whose range has been thought to be in the lower coastal plain from Florida north to North Carolina.

Juncus brachycephalus (Engelm.) Buchenau

TENNESSEE. LEWIS COUNTY: seepage bog in oak-hickory, by Tennessee 99, 3.5 miles southwest of Hampshire, 26 August 1969, *Kral* 36371. MAURY COUNTY: seepage area on bluffs above Big Bigby Creek just southwest of Rockdale on US 43, 6 October 1967, *Kral* 29393. WAYNE COUNTY: 5.5 miles east of Waynesboro off US 64; gravelly streambank in oak-hickory hills, 4 September 1971, *Kral* 43947.

This essentially northern rush has not been reported previously from further south than Indiana and Illinois. In the abovementioned Tennessee localities it is extremely abundant, often in association with masses of *Parnassia*.

Juncus nodatus Coville

ALABAMA. PICKENS COUNTY: backwater slough, bases submersed, 4.6 miles south of Aliceville off Alabama 17, 5 June 1971, *Kral* 43022.

This is an essentially western gulf coastal plain *Juncus*, previously known from no further east than Mississippi, with stations inland from Indiana west to Kansas.

Allium stellatum Ker

TENNESSEE. DAVIDSON COUNTY: cedar glade, east Nashville, across from Mt. View School, *Baskin* and *Caudle* 5-b, September 25, 1965; RUTHERFORD COUNTY: cedar glade 4 miles northeast of La Vergne, 28 September 1946, *E. Quarterman* 1874; 23 September 1950, *E. Quarterman* 4227.

This species, an extension southward or eastward from

the prairie provinces, distinguishable from *A. cernuum,* on the basis of its shorter bulbs, erect flowering scapes (in contrast to distal nodding in *A. cernuum*), and its narrower and more spreading perianth segments, is locally abundant in the limestone barrens of Middle Tennessee, where its height of flowering is usually from mid-September well into October. Putative intermediates between it and *A. cernum* are abundant in the same area.

Lachnanthes caroliniana (Lam.) Dandy
Gyrotheca tinctoria (Walt.) Salisb.
TENNESSEE. COFFEE COUNTY: peat and muck along edge of Goose Pond, just east of Arnold Center, 17 August 1970, *Kral* 40679.

This species so typical of bogs and flatwoods of the lower Atlantic and Gulf coastal plain, has not been reported previously from Tennessee. Indeed this record might constitute the furthest one inland for the species, further proof of the strong coastal plain floristic affinities of the "oak barren" country of middle Tennessee.

Hypoxis juncea J. E. Sm.
ALABAMA. GENEVA COUNTY: sandy peat of pineland bog edge, between Geneva and Samson on Alabama 52, 27 April 1969, *Kral* 34551.

An extension of known range westward from Florida and Georgia.

Canna flaccida Salisbury
ALABAMA. MOBILE COUNTY: inland edge of salt marsh, in slash pine, Bayou La Batre, 7 June 1971, *Kral* 43053.

A first report for Alabama of this distinctive, yellow-flowered *Canna* that has been known previously from Florida north to South Carolina and also from coastal Mississippi.

Salix rigida Michx.
ALABAMA. PIKE COUNTY: banks of Whitewater Creek 5 mi. e.s.e. Spring Hill on Ala. 6, 30 Mr. 1968, *Kral* 29967.

Sufficiently rare in Alabama (though reported for the state by Small, 1933) as to be worth mention here.

Boehmeria nivea (L.) Gaudich.

Ramium niveum (L.) Small

ALABAMA. COVINGTON COUNTY: weedy subshrub of sandy empty lot by US 331, s. side Opp, 12 October 1970, *Kral* 41696. ESCAMBIA COUNTY: weedy subshrub, Atmore, 19 September 1971, *Kral* 44413.

Reported by Mohr as an occasional escape from cultivation in southern Alabama, but infrequent enough to deserve mention here.

Polygonum erectum L.

ALABAMA. JACKSON COUNTY: rich limestone woods by upper Paint Rock Creek & Ala. 65, ca. 7 mi. n. Princeton, 30 September 1971, *Kral* 44588.

A first report for Alabama of this more northerly weed.

Polygonella fimbriata (Ell.) Horton

Thysanella fimbriata (Ell.) Gray

ALABAMA. GENEVA COUNTY: sandy, live oak forested west banks of Choctawhatchcee River between Geneva and Eunola beside Ala. 52, 18 September 1971, *Kral* 44348.

Reported by Small for Alabama, but not by Horton for the state in his revision of *Polygonella* (Brittonia 15: 177-203, 1963). The Small citation is based on a collection used by Mohr, made by Dr. E. A. Smith from Geneva County, perhaps from the same locality.

Persicaria bicornis (Raf.) Nieuwl.

Polygonum longistylum Small

ALABAMA. LIMESTONE COUNTY: gravelly creek bottoms by US 31, 1 mi. n. Athens and jct. Ala. 127, 3 October 1968, *Kral* 33471.

Range extended eastward from Mississippi.

Antigonon leptopus H. & A.

Corculum leptopus (H. & A.) Stuntz.

ALABAMA. MOBILE COUNTY: naturalized along rail-

way, s. side Mobile in old part of town near Bay, 23 September 1969, *Kral* 37385.

This showy species, called "Coral Vine" in Florida, is frequently cultivated and escaped there; it is often found in cultivation in the gulf coastal plain toward the actual coast. In the Mobile area, it persists around old homesites and in the negro parts of the old city, but was not reported from there by Mohr.

Silene gallica L.

ALABAMA. MOBILE COUNTY: sands of large clearing by Battleship Park, along US 90-98 causeway over Mobile Bay, 16 April 1967, *Kral* 28441.

Range extended southward from Kentucky and Tennessee or over from Georgia.

Tunica prolifera (L.) Scop.

Dianthus prolifer L.

ALABAMA. MARION COUNTY: bluffs on North Fork Creek by Ala. 17, n. of Hamilton; sandy roadbank of Ala. 17, 20 July 1970, *Kral* 40202.

A first report for Alabama of this European weed which appears (according to Fernald, *op. cit.*) to be naturalizing in the northeast.

Thalictrum mirabile Small

TENNESSEE. OVERTON COUNTY: bluffs above West Fork of Obey River by Tenn. 52, 3.4 mi. e. Alpine, 31 April 1971, *Kral* 42321.

A first report for Tennessee of this rare species, previously found only in Kentucky and Alabama.

Thalictrum debile Buckl.

ALABAMA. GREENE COUNTY: blackland woods off US 43, 2.7 mi. s. Eutaw, 1 April 1968, *Kral* 30006. LAWRENCE COUNTY: silty clay of Town Creek bottoms n.w. Hatton by where crossed by Ala. 157, 10 April 1969, *Kral* 34151.

This unique little species of heavy clay soils, usually in prairie border woods or alluvial woods, has its type locality

in Wilcox County. It is similar in habit to *T. dioicum*, but more delicate, and its rootstock consists of a dense fascicle of inch-long, fusiform tubers (very similar to those of *Anemonella*). It flowers in March and April, and is usually gone back to rootstock by late May. Taxonomically it is closest to *T. texanum* (gray) Small. This complex, which includes some Mexican species as well, should be appraised further.

Thalictrum macrostylum Small & Heller

ALABAMA, JACKSON COUNTY: low sandy woods by Ala. 71, ca. 2 mi. s. Pisgah, 4 June 1969, *Kral* 34979.

An extension of known range southward from Tennessee.

Cardamine douglassii (Torr.) Britt.

ALABAMA. COLBERT COUNTY: clay loam of bluffs above Tennessee River at Muscle Shoals, ca. 0.5 mi. w. of US 43 bridge crossing, 9 April 1969, *Kral* 34091. JACKSON COUNTY: rich wooded slopes by Ala. 65, 5.1-7.1 mi. s. Huntland, 18 April 1971, *Kral* 42095. LAWRENCE COUNTY: clay of wooded slope above tributary stream above Tennessee River near paved county rd., ca. 15 mi. e. Joe Wheeler Dam, 30 March 1971, *Kral* 41498. MARENGO COUNTY: woods, n. facing slope, 1 mi. n. Linden by US 43, 1 April 1968, *Kral* 30025.

Reported here as new to the Alabama flora. Mr. Richard Simmers of Ithaca, N.Y., an excellent field biologist now active in Alabama, has records for the species from Clarke and Madison counties. The pubescence character that is fairly consistent in populations of this species in middle Tennessee varies greatly in the northern Alabama populations, so that some individuals of a given population are usually completely glabrous. Petal color also ranges more, from pure white to the deep fine pink that is typical. It would appear that there is intergradation with *Cardamine bulbosa* (L.) B.S.P.; the complex should be reappraised.

Diplotaxis muralis (L.) DC

ALABAMA. MARENGO COUNTY: 2.3 mi. s. Demopolis on US 43, chalk prairie, 6 June 1968, *Kral* 31217.

HALE COUNTY: chalk glade, 4.2 mi. w. Faunsdale, 9 September 1968, *Kral* 33087.

A European weed, heretofore not reported from Alabama, and rarely from the Small's Manual range. The flowers, a bright yellow, are quite showy against the white of the chalk barrens it frequents.

Warea amplexifolia (Nutt.) Nutt.
W. sessilifolia Nash

ALABAMA. PIKE COUNTY: sandy clearings amongst longleaf pine, Big Pocosin, s.e. Troy, n.e. Fairgrounds, 10 September 1968, *Kral* 33165.

According to Small, the only species of *Warea* known to occur in Alabama is *W. cuneifolia*, a species whose leaves broaden upward. The Pike county material has distinctive, sessile, ovate blades, and agrees in all other respects with material of *W. amplexifolia* I have from western Florida.

Polanisia dodecandra (L.) DC

TENNESSEE. HICKMAN COUNTY: gravelly banks of Beaverdam Creek s. of Centerville on Tenn. 100, 20 September 1968, *Kral* 33430. HOUSTON COUNTY: banks of Yellow Creek 7 mi. w. Van Leer, 2 August 1969, *Kral* 35860. HUMPHRIES COUNTY: banks of Big Richland Creek by Tenn. 13, 6 mi. n. Waverly, 4 August 1969, *Kral* 35076.

Iltis (Brittonia 10:46, 1958) shows in his excellent monograph but two counties in western Tennessee for this species. It appears to be quite abundant in middle Tennessee in that additional records of it from Cheatham, Davidson and Lewis counties, but not yet processed, have been gotten. In the area of this study, the species is almost always on gravel bars of streams.

Fothergilla major Lood.

ALABAMA. CHEROKEE COUNTY: boulder strewn, sandy, wooded banks of Little River Canyon, Canyon Mouth branch of De Soto State Park, 12 April 1969, *Kral* 34269.

Reported long previously from Alabama by Small (*op.*

A first report for Alabama, but appears already well established in Mississippi. Another clover of Old World origin that is being experimented with by agronomists here.

Geranium robertianum L.

TENNESSEE. SMITH COUNTY: shaded limestone cliffs above Cumberland River, 3.8 mi. n. Chestnut Mound off Tenn. 53, 30 April 1971, *Kral* 43249.

A first report for Tennessee of this essentially northern species. According to Fernald the species is introduced from Eurasia, so that its appearance in the rugged, to all appearances undisturbed, Smith County location is surprising.

Linum westii Rogers

FLORIDA. FRANKLIN COUNTY: peaty shallows of ditch in slash pine-saw palmetto flatwoods near tidal estuary, 8.2 mi. n. jct. Fla. 65 and US 98, 9 July 1970, *Kral* 39896.

C. M. Rogers (Brittonia 15: 1963) reports this as one of the rare plants of the south and indicates that most of the collections examined in his study were gotten in Florida by Chapman. Only one of these had definite locality, "Apalachicola", which seems to have meant a large part of Franklin County to Chapman. The type of the species is from the only other Florida collection, this made from far to the east in Baker County by West and Arnold in 1946. In addition Rogers cites one collection from Rome, in Floyd County, Georgia, but with some reservations. In that this particular specimen is again from Chapman, and in that flatwoods habitat of the sort *L. westii* frequents is so far removed from Rome, Georgia, one might suspect a label mix-up.

I discovered this *Linum* whilst travelling north toward Telogia along the lonely stretches of Fla. 65, and was at once struck by the large patches of handsome, pale yellow corollas, these fully open at ca. 6:00 p.m. As Rogers suspected and mentioned in his description, it is a perennial.

It spreads by basal offshoots, but tends also to form one rootstock several ascending, strict, flowering shoots.

Acalypha setosa Richard

ALABAMA. ESCAMBIA COUNTY: lot weed, sandy ground, Atmore, 19 September 1971, *Kral* 44404. LEE COUNTY: lawn weed, Opelika, 16 July 1971, *Kral* 43370.

Already reported by L. A. W. Miller (Thesis, 1970) for Alabama, but shown only for Mobile County.

Vitis munsoniana Simpson

ALABAMA. ESCAMBIA COUNTY: sandy bottoms of Escambia Creek where crossed by I-65, n.e. Atmore, 27 July 1969, *Kral* 35636.

Extension of known range westward from Florida and Georgia.

Sida elliottii T. & G.

ALABAMA. BIBB COUNTY: calcareous rock outcrop area ca. 5 mi. n. Centerville on Ala. 5, 5 September 1970, *Kral* 41092.

This has been reported from Alabama since Mohr, but it is not at all a common species there or anywhere else within its range. I am of the opinion that narrow-leaved material of other species is often referred erroneously to this taxon. To those like myself who have had experience primarily with the commoner southeastern sidas, a first experience with this one is startling. The plants of the Bibb Co. locale had their flowers fully open at ca. 4:00 p.m. The corollas are particularly striking, being of an intense orange-yellow (far more orange than other eastern species I have seen). Most of the plants had several strong, but slender and decumbent shoots from a central, stout, very large caudex. The overall effect of these particular plants was quite harmonious, and were the species a heavier bloomer, it would make a very good horticultural risk. The open corollas are fully 2.5 cm. broad, much larger than those of other eastern species.

Cuphaea carthaginensis (Jacq.) MacBr.

ALABAMA. MOBILE COUNTY: between Fowl River

and Delchamps on Ala. 59; sandy roadbank, 5 October 1971, *Kral* 44869.

A first report for Alabama; fairly common as a weed of moist sandy ground in southern Georgia, northwestern Florida, and southern Mississippi.

Rhexia salicifolia Kral & Bostick

ALABAMA. COVINGTON COUNTY: sandy shores of Open Pond, Blue Spring Mgmt. Area, Conecuh Nat. Forest, s.w. Andalusia, 31 August 1970, *Kral* 40928; Blue Pond, s.w. Andalusia in Conecuh Nat. Forest, 31 August 1970, *Kral* 40932. HOUSTON COUNTY: sandy shores and shallows of Indigo Pond, s.e. Cottonwood, 9 June 1971, *Kral* 43118.

An extension northward from northwestern Florida, where it is not rare on the shores of limesink lakes and ponds. In Alabama, as in Florida, it often is in association with *Rhexia mariana* var. *mariana* and sometimes produces hybrids with it (*Kral* 40929, 40937). These usually form few seeds, the capsules more often falling off before ripening. In this they are similar to hybrids between *R. mariana* and *R. virginica.*

Epilobium ciliatum Raf.

TENNESSEE. GILES COUNTY: by Tenn. 11, 3 mi. n.e. Minor Hill; wet meadow in shaley hills, 17 September 1969, *Kral* 36940.

An extension southward from Kentucky.

Ludwigia spathulata T. & G.

Isnardia spathulata (T. & G.) Small

ALABAMA. BALDWIN COUNTY: just s. Perdido on county 47 on drying bottoms of sandy pond, 21 October 1969, *Kral* 38179. BARBOUR COUNTY: sandy open seepage area by Lake Eufaula, ca. 5 mi. s. Eufaula off US 431, 11 Sept. 1968, *Kral* 33226. COVINGTON COUNTY: sandy north shore of Lake Jackson, Florala, 3 September 1969, *Kral* 36818. GENEVA COUNTY: 1 mi. s.w. Hartford on edge of pond cypress lake, 12 August 1966, *S. McDaniel* 7646.

An extension westward from Georgia or northward from s.w. Florida. First discovery of it in Alabama is credited to Dr. McDaniel.

Ludwigia sphaerocarpa Ell.

TEXAS. MONTGOMERY COUNTY: peaty bottoms, 12 mi. w. Cleveland, 24 July 1964, *Kral* 21041.

Dr. Raven, who made the identification in 1967, annotates: "extremely pubescent. Apparently new to Texas."

Ludwigia suffruticosa Walt.

ALABAMA. HOUSTON COUNTY: sandy upper banks of Indigo Pond, s.w. Cottonwood, 1 August 1971, *Kral* 43405.

Extension of range westward from Georgia or northward from west Florida.

Myriophllym exalbescens Fern.

ALABAMA. JACKSON COUNTY: ca. 4 mi. e. Scottsbora; edge of lake, formerly Coosa River, 14 September 1968, *Kral & Blum* 33311.

Of general distribution as an aquatic, but apparently not of frequent occurrence in the southeast; new for Alabama.

Spermolepis inermis (Nutt.) M. & C.

S. patens (Nutt.) B. L. Robins.

ALABAMA. BALDWIN COUNTY: ca. 3 mi. w. jct. Ala. 59 and Ala. 180 toward Ft. Morgan; sand pine-magnolia, 16 April 1967, *Kral* 28397. GENEVA COUNTY: sandy areas above Pea River 2 mi. w. Samson, 17 April 1970, *Kral* 38680.

More western, from prior reports, save for isolated records in North Carolina and Tennessee; a first record for Alabama.

Ptilimnium costatum (Ell.) C. & R.

ALABAMA. ST. CLAIR COUNTY: ca. 2 mi. s. Asheville on US 231; prairie-like area by road, 15 August 1968, *Kral* 32348.

Reported already for Alabama (Radford *et al*, Guide to the Vascular Flora of the Carolinas, p. 252, 1964; Manual of the Vascular Flora of the Carolinas, p. 784, 1968), but this essentially western gulf coastal plain umbellifer is infrequent in the state.

Cornus amomum Mill. ssp. *microcarpa* (Nash) Wilson
Svida microcarpa (Nash) Small
ALABAMA. ESCAMBIA COUNTY: ca. 10 mi. e. Brewton on co. 4, by Conecuh River, 8 June 1969, *Kral* 35154. GENEVA COUNTY: sandhills above Pea River ca. 6 mi. s. jct. Ala. 52-153, 7 June 1969, *Kral* 35044.
A first record for Alabama.

Cornus purpusii Koehne
TENNESSEE. MAURY COUNTY: just above Rockdale on US 43, rocky shaley bluffs above small tributary of Big Bigby Creek, 26 June 1970, *Kral* 39738.
An extension southward from Kentucky.

Rhododendron austrinum (Small) Rehder
Azalea austrina Small
ALABAMA. COVINGTON COUNTY: sandy bottoms of 5 Runs Creek by Stanley Community off Ala. 55, 16 April 1970, *Kral* 38596; sandy creekbank 4.5 mi. e. Wing on Co. 4, 18 April 1970, *Kral* 38739. COFFEE COUNTY: sandy Pea River bottoms off Ala. 134, e. of Opp and Perry, 17 April 1970, *Kral* 38652. ESCAMBIA COUNTY: sandy bottoms Conecuh River, e. of Brewton on US 29, by hwy. bridges, 18 April 1970, *Kral* 38724. GENEVA COUNTY: sandy woods by Flat Creek, by Ala. 54, w. of Samson, 16 April 1970, *Kral* 38619; sandy bluffs above Pea River 2 mi. w. Samson, 17 April 1970, *Kral* 38672; sandy bluffs above branch, 4 mi. w. Geneva on Ala. 52, then ca. 3 mi. n.e. by county rd., 17 April 1970, *Kral* 38688.

Already reported for Alabama, though not mentioned for the state by Small. Dr. Clark (thesis, 1969) lists 9 counties, one of which is Appalachian. This species equals *R. calendulaceum* (Michx.) Torr. in flamboyance, and is

hardly distinguishable save for the pubescence on the backs of the bud scales and the glandular hairs of the twigs. The difference sometime utilized, namely that flowers emerge after the leaves have unfolded, as has already been noted by others, is inconstant. *R. austrinum* will hybridize with *R. canescens* (Michx.) Sweet, which almost always is in the same areas with it, though usually *R. canescens* is in bloom first. Both have the same "woodsy" fragrance, to me very similar to that of *Phlox divaricata* L.

Lysimachia gramineum (Greene) Handel-Mazzetti
Steironema gramineum Greene

ALABAMA. CHEROKEE COUNTY: ca. 2 mi. s. Centre; sandy swale by Ala. 9, spreading by slender rhizomes, 22 July 1968, *Kral* 31898.

To quote from J. S. Ray (Ill. Biol. Monogr. 24: 39):

> "Lysimachia gramineum Greene, known only from specimens from the type locality, "Northern Alabama," is included here in 1878 by G. R. Vasey, probably near Gadsden, the type material, represented by two sheets in the U.S. National Herbarium and a fragmentary specimen in the Gray Herbarium, is perhaps not even typical of its kind. The stem, either cut or grazed near its base, consists of several attenuated lateral shoots. Narrowly linear leaves, small flowers, and capsules all range in size below those of ssp. lanceolata, yet there is not sufficient evidence for a distinct taxon. E. L. Greene emphasized the long filiform filaments which greatly exceed the short oblong-oval anthers. However, these are not unlike others of the southeastern populations."

My own samples were from an enormous population, probably an acre in extent, but strikingly uniform and with fruits uniformly smaller than those of *L. lanceolata*. Further field work in northeastern Alabama ought to reveal still more of this, now known to be in at least two counties.

Lysimachia quadriflora Sims

Steironema quadriflorum (Sims) Hitchc.

ALABAMA. CHEROKEE COUNTY: peaty seepage area by Ala. 9, 6 mi. s. Centre; forming large stand by rhizomes, 21 July 1968, *Kral* 37142.

According to Ray (*op. cit.*) This essentially northern species does extend south into Arkansas and Georgia, but not into Alabama. It has very large, handsome yellow flowers similar to those of *L. lanceolata.*

Sabatia difformis (L.) Druce

ALABAMA. GENEVA COUNTY: sandy peat of savanna-bog by Ala. 4, ca. 10 mi. e. Florala, 2 August 1971, *Kral* 43437.

Extension of range probably northward from northwestern Florida.

Sabatia quadrangula Wilbur

S. paniculata (Michx.) Pursh

ALABAMA. HOUSTON COUNTY: e. side Ashford on sandy peaty swale by railroad, 5 June 1964, *Kral* 20523; 16 July 1970, *Kral* 40019.

Extension of range westward from Georgia or northward from Florida.

Amsonia rigida Shuttlw.

ALABAMA. GENEVA COUNTY: 5.3 mi. s. Samson on Ala. 87; edge of gum bottom; cor. near white, fls. faintly fragrant, 26 April 1969, *Kral* 34502.

Extension of known range westward from Georgia or northward from Florida.

Asclepias hirtella (Pennell) Woodson

Acerates hirtella Pennell

TENNESSEE. BLEDSOE COUNTY: upper edge of marsh meadow by Tenn. 30, 8 mi. e. entrance to Bledsoe Forest, 8 August 1970, *Kral* 40297. LEWIS COUNTY: sandy oak-hickory woods, clearing, ca. 2 mi. s. Meriwether Lewis entrance at Tenn. 20 and by road to Metal Ford,

6 August 1969, *Kral & Demaree* 36192; 4.2 mi. e. Hohenwald on sandy clay of high pasture, 27 August 1969, *Kral* 36404. ALABAMA. ST. CLAIR COUNTY: prairie, s. side Asheville, 16 July 1971, *Kral* 43388.

Some slight mystery as to range of this species exists. Small reports it from Alabama, thence "to Okla., Ill., and Mich."; however Woodson (Ann. Mo. Bot. Gard. **41**: 170-171, 1954) does not report it for Alabama and shows but one station for it in Tennessee (Franklin Co.). Therefore, the species is mentioned here simply to add locality information.

Asclepias tomentosa Ell.

A. aceratoides M. A. Curtis

FLORIDA. FRANKLIN COUNTY: sandy areas by coast, Alligator Point, 9 July 1970, *Kral* 39898.

Some restatement as to distribution of this species is perhaps in order. Small reported *A. aceratoides* from North Carolina and South Carolina and *A. tomentosa* for Florida and Georgia; Woodson (*op cit.*), considering the two as one species, shows what appears to be an interesting disjunction, namely that the species is in peninsular and northeastern Florida, then in North and South Carolina (as indicated by Small). Then he shows it in Texas, indicating Polk County in his text, but indicates several counties in Texas for it on his map. The disjunction becomes much less if the several collections by Godfrey (and others) from northwestern Florida are added to the information. It appears there primarily in sandhills along the coast.

Ipomoea muricata (L.) Jacq.

ALABAMA. ESCAMBIA COUNTY: weedy along railroad, w. side Atmore; fls. in evening, 19 September 1971, *Kral* 44416.

Very distinctive with its bristly muricate stems and narrowly funnelform, lavender-tinted, corollas that open toward evening; a first report for Alabama. Previously reported from Florida and Texas.

Phlox pilosa L. var. *ozarkana* Wherry

TENNESSEE. MAURY COUNTY: shaley, w. facing oak-hickory slopes by US 43, just above Rockwood, on rim, 3 June 1971, *Kral* 42847.

Wherry indicates (The Genus Phlox, Morris Arboretum Monographs III, pp. 44-45, 1955) two disjunct areas, one essentially ozarkian and the other primarily in central and northern Alabama, also extreme western Georgia. He does not report it for Tennessee.

Verbena bipinnatifida Nutt.

Glandularia drummondii (Lindl.) Small

ALABAMA. GREENE COUNTY: chalk prairie 6.5 mi. s. Eutaw on US 43, 5 June 1968, *Kral* 31082. MARENGO COUNTY: 2.3 mi. s. Demopolis on US 43; chalk prairie, 6 June 1968, *Kral* 31215. MONTGOMERY COUNTY: roadside weed s. side Montgomery, 21 May 1968, *Kral* 30953. SUMTER COUNTY: chalk outcrop 3 mi. n.n.e. Livingston, *Kral* 23786; patch of chalk prairie, by Ala. 17, 8 mi. s. Dancy, 4 June 1970, *Kral* 39643.

Very abundant and showy in late spring and into the summer on the black earths and outcrops of the chalk prairies in Alabama; probably in every black belt county. However, not reported by Small from e. of La. A common verbena of the prairie provinces of the west and midwest; already reported for Alabama by Harper (Ala. Geol. Surv. Bull. 53, 1944) and L. M. Perry (Annals Mo. Bot. Gard. **20**: 323, 1933).

Collinsonia canadensis L.

ALABAMA. CRENSHAW COUNTY: longleaf pine flatwoods 3.5 mi. n. Brantley, 5 October 1968. *Kral* 33711.

According to Shinners (Sida 1, p. 80) this species is rare in the coastal plain; he cites but one collection, this by Buckley and without definite locality.

Hedeoma drummondii Benth.

ALABAMA. MARENGO COUNTY: 2.3 mi. s. Demopolis on US 43; chalk prairie, 6 June 1968, *Kral* 31210. SUM-

TER COUNTY: north of Livingston on hwy. 11, prairie area, *K. E. Rogers,* 29 May 1970.

This species of the prairie districts of the western U.S. is here recorded as a rarity; it has already been reported for Alabama by Harper (*op. cit.*).

Stachys floridana Shuttlw.

ALABAMA. BALDWIN COUNTY: e. end of US 90-98 causeway over Bay, e. of Mobile; moist sandy cleared area by highway, 19 April 1970, *Kral* 38799.

While Small reported this only from Florida, Dr. Sam Jones and others have collected and reported this from Alabama. It is still rare enough there to be noteworthy, and very distinctive because of the slender, elongate stolons terminating in pale, fusiform tubers. Very weedy where found, and likly to expand its range accordingly.

Stachys hispida Pursh

TENNESSEE. HOUSTON COUNTY: sandy gravelly wooded banks of Yellow Creek, near where crossed by Tenn. 49, w. of Van Leer, 16 June 1969, *Kral* 35276.

An extension of known range southward from Kentucky.

Scutellaria racemosa Pers.

ALABAMA. BALDWIN COUNTY: sandy-gravelly railroad embankment through Hypericum pond just n. of jct. I-10 off Ala. 59 and 6 mi. s. Stapelton, 8 June 1971, *Kral* 43084.

A first report for this species for the U.S.A. There are specimens of it at the U.S. National Museum from Argentina, Bolivia, Chile, Paraguay, Uruguay and Central America. It is distinctive in its very small flowers (ca. 3 mm. long), and in its peculiar rootstock which consists of numerous, pale, quite elongate stolons from which branch fleshy, fusiform-cylindrical tubers.

Mosla dianthera (Buch.) Maxim.

TENNESSEE. MARION COUNTY: sandy pockets in sandstone glades 8.5 mi. s. Grundy Co. line and Tracy City, 29 September 1971, *Kral* 44514; sandstone outcrop area by

Fish Branch, by Tenn. 108, 3 mi. n. Whitwell, 29 September 1971, *Kral* 44522.

An extension southward from Kentucky. Very like *Perilla*.

Monarda clinopodia L.

ALABAMA. MADISON COUNTY: rich loamy banks of Mountain Fork Creek 4.5 mi. n.e. New Market, 15 July 1971, *Kral* 43341.

An extension southward from Tennessee.

Hyptis mutabilis (Rich.) Briq.

ALABAMA. BALDWIN COUNTY: edge of longleaf pine sandridge by US 98, 3.5 mi. n. Montrose, 9 October 1967, *Kral* 29806. COVINGTON COUNTY: sandy roadbank, in pine flatwoods ca. 13.5 mi. s. opp on US 331, 17 August 1968, *Kral* 32504. RUSSELL COUNTY: weed in empty sandy lot, Hurtsboro, 12 September 1968, *Kral* 33281. I have other, yet unprocessed records from Escambia and Mobile counties.

This native of South America is credited in the United States only to Florida by Small.

Physalis longifolia Nutt.

P. sulglabrata Mackenzie & Bush

ALABAMA. MONTGOMERY COUNTY: clay loam of cultivated area, 4 mi. s. of Loop Road, s. side Montgomery, 1 June 1970, *Kral* 39479. PICKENS COUNTY: just s. of Cochrane; woods at border of chalk prairie, 5 June 1971, *Kral* 42997.

An extension of range southward from Tennessee; probably more abundant in the black belt than present collections indicate.

Veronica anagallis-aquatica L.

ALABAMA. MADISON COUNTY: banks of Mountain Fork Creek, 1.3 mi. n.e. New Market off Old Mountain Fork Road, 15 July 1971, *Kral* 43359.

An extension southward from Tennessee.

Lindernia crustacea (L.) F. von Muell.

ALABAMA. ESCAMBIA COUNTY: wet sands of nursery lot, Atmore, 19 September 1971, *Kral* 44407.

A first report for Alabama; already reported from Florida and Mississippi.

Utricularia resupinata Greene

Lecticula resupinata (Greene) Barnh.

ALABAMA. COVINGTON COUNTY: sandy shallows of north shore Lake Jackson at Florala, 3 September 1969, *Kral* 36008.

An extension northward from northwest Florida.

Diodia hirsuta Pursh.

ALABAMA. WASHINGTON COUNTY: 5 mi. s. Chatom in pineland bog, 14 July 1969, *Kral* 35534.

This entity, considered part of *D. virginiana* L. by some authors, (*i.e.*, Radford *et al.*, *op. cit.*), is certainly distinctive, and has not been reported previously save from the Atlantic coastal plain from Florida to North Carolina.

Plantago hookeriana Fisch. & Mey.

P. wrightiana Decaisne

ALABAMA. BALDWIN COUNTY: railroad gravels above Hypericum pond just n. jct. I-10 on Ala. 59 and 6 mi. s. Stapelton, 8 June 1971, *Kral* 43083. GENEVA COUNTY: sandy edge of field between Geneva and Samson on Ala. 52, 27 April 1969, *Kral* 34565; sandy railroad right of way, 0.5 mi. w.n.w. Geneva on Ala. 52, 17 April 1969, *Kral* 38703. HOUSTON COUNTY: sandy railbanks above Little Choctawhatchee Creek on Ala. 92, 1.7 mi. w. jct. US 94, 9 June 1971, *Kral* 43156. LEE COUNTY: dry sandy oak-pine woods, clearing, by Ala. 169, 4 mi. n. Crawford, 9 May 1968, *Kral* 30773. MONTGOMERY COUNTY: NW side Montgomery on RR gravels by US 31-jct. bypass, 5 June 1969, *Kral* 34989.

Shinners (*op. cit.*) treated this part of the *P. patagonica* complex as *P. wrightiana* rather than as a variety of *P. hookeriana* as did Poe. My own records of it in Alabama appear to be new records for the state, but this essentially

western weed has been collected from the coastal plain of Georgia and North Carolina (Radford, *et al*).

Valeriana pauciflora Michx.

ALABAMA. MADISON COUNTY: rich loamy woods along Mountain Fork Creek, n.e. New Market, 4 May 1971, *Kral* 32485.

An extension southward from Tennessee.

Liatris chapmanii T. & G.

Laciniaria chapmanii (T. & G. Kuntze

ALABAMA. BALDWIN COUNTY: sandy banks and flats of scrub above River Styx, by where crossed by co. rd., ca. 5 mi. n.n.e. Elsanor, 2 September 1970, *Kral* 41029. ESCAMBIA COUNTY: 2.7 mi. s.w. Flomaton along US 31; sandy clay roadbank in longleaf pine-turkey oak hills, 6 September 1965, *Kral* 25950.

An extension northward from northwest Florida, where it locally abounds in sandhills.

Xanthocephalum dracunculoides (DC) Shinners

Gutierrezia dracunculoides (DC) Blake

TENNESSEE. DAVIDSON COUNTY: ca. 1 mi. w. Scottsboro on Tenn. 12, 9 September 1957, *H. F. L. Rock* 887. RUTHERFORD COUNTY: edge of wet limestone glade, ca. 2 mi. s.s.e. Murfreesboro by US 41, 6 October 1969, *Kral* 37551; limestone glade by US 70S, 3.8 mi. e. Murfreesboro, 9 August 1970, *Kral* 40326; limestone glades 3 mi. s. Murfreesboro by US 231, and 8.1 mi. n. Deason, 27 August 1970, *Kral* 40755.

This broomweed is extremely abundant in open limestone glades in Rutherford and Davidson counties but evidently has not been in the area very long, for while it is mentioned for Alabama by Fernald (*op. cit*), there is no reference to it for Tennessee prior to the Rock collection and other contemporary collections made through the University of Tennessee. Common westward in Missouri, Oklahoma, Arkansas, and Texas in essentially calcareous districts; more local northward in the interior lowlands.

Solidago elliottii T. & G.

ALABAMA. GENEVA COUNTY: 0.3 mi. n. jct. Ala. 153 and Ala. 52 on Ala. 52; sandy peat of longleaf pine savanna-bog, 6 October 1968, *Kral* 33756.

An extension of known range westward from the southern Atlantic coastal plain.

Solidago ulignosa Nutt.

ALABAMA. JACKSON COUNTY: sandy clay summit, seepage, of Sand Mt., off Ala. 117, 5.2 mi. n. Flat Rock, 7 October 1969, *Kral* 37590.

This essentially northeastern bog species has been reported previously from no further south than North Carolina.

Aster chapmanii T. & G.

ALABAMA. GENEVA COUNTY: sandy peat of longleaf pineland savanna by county 4, 11 mi. e. Black, 28 October 1969, *Kral* 37951. HOUSTON COUNTY: sandy peat of longleaf pine flatwoods savanna ca. 1 mi. s.e. Cottonwood, 12 October 1970, *Kral* 41656.

Extension of range northward from northwestern Florida. The Alabama localities are both threatened by either real estate development or farmers, who convert the rich black peats to use for row crops.

Aster eryngiifolius T. & G.

ALABAMA. COVINGTON COUNTY: longleaf pineland sandhills bog by US 331, ca. 3 mi. n. Florala, 26 July 1968, *Kral* 32096. GENEVA COUNTY: by county 4, ca. 10 mi. s. intersection US 231, in pineland savanna, 8 June 1968, *Kral* 31350.

An extension of known range northward from northwestern Florida.

Aster spectabilis Ait.

ALABAMA. DEKALB COUNTY: swale in sandrock hills, oak-pine, on county 89, ca. 4 mi. s. DeSoto State Park Hq., 29 August 1969, *Kral* 36491; sandy loam around sandrock, and under oak-pine, ca. 4 mi. n.e. Ft. Payne, 8 Octo-

ber 1969, *Kral* 37644; sandy powerline clearing DeSoto Parkway just n. of Ala. 35, e. of Ft. Payne, 28 August 1970, *Kral* 40793.

This very showy aster, a worthy subject for cultivation on sandy soils, appears not to have been reported previously for Alabama. An extension southward and eastward from western North Carolina.

Conyza bonariensis (L.) Cronquist

Leptilon bonariense (L.) Small

ALABAMA. ESCAMBIA COUNTY: sandy longleaf pine woods above Perdido Creek, ca. 7 mi. w.s.w. Atmore, 18 August 1968, *Kral* 32576. MOBILE COUNTY: Battleship Park, by causeway e. of Mobile on the Bay, 20 August 1968, *Kral* 32756; sandy empty lot, w. side Mobile near jct. International Drive and Interstate Hwy. 10, 2 September 1970, *Kral* 41012.

Reported in Small as only from Florida but since collected by Demaree in Mississippi and probably more abundant in Alabama than present records indicate. It is always on sandy disturbed grounds, and therefore much in evidence along the newer highways toward the coast.

Erigeron myrionactis Small

E. repens A. Gray, 1884; not (HBK) Weddell, 1857.

MISSISSIPPI. JACKSON COUNTY: trailing over sandy road shoulder, Old US Rt. 90, ca. 5 mi. e. Ocean Springs, *R. B. Channell* 3561, 12 July 1955.

Here cited as new for Mississippi. Reported in Small (Flora, 1903) as a weed of the coast of Texas and Louisiana.

Iva microcephala Nutt.

ALABAMA. BARBOUR COUNTY: sandy pineland above W. F. George Reservoir (Lake Eufaula), s. of Eufaula off Ala. 95, 18 October 1969, *Kral* 38023. HOUSTON COUNTY: sandy bluff above Cedar Creek where crossed by Ala. 95, s. of Columbia, 18 October 1969, *Kral* 37962.

An extension westward from Florida, Georgia.

Iva annua L.

I. ciliata Willd.

TENNESSEE. RUTHERFORD COUNTY: edge of marshy area, heavy soil, s. side Murphreesboro on US 231, 27 August 1970, *Kral* 40764.

This essentially western weed is of scattered distribution east of the Mississippi, save in the black belt where it is common on disturbed heavy soils. This Tennessee report is probably an extension from Alabama.

Ambrosia bidentata Michx.

TENNESSEE. DAVIDSON COUNTY: field next to open limestone glades by Mountain View Road, n. of Murphreesboro Rd., toward Percy Priest Lake, 14 August 1968, *Kral* 32342. RUTHERFORD COUNTY: gravelly, calcareous road shoulders beside I-24 jct. Buchanan Road, 7.7 mi. n.w. Beech Grove, 19 August 1971, *Kral* 43641.

This ragweed hitherto reported for w. Tennessee by Gattinger (Flora of Tennessee, 1900) and from east Tennessee recently (Sharp *et al,* Preliminary Checklist of Dicots in Tennessee, p. 105, 1960) but not subsequently in the manuals, must be an extension from the calcareous districts of the mid-west. Evidently spreading rapidly in Tennessee.

Rudbeckia mollis Ell.

ALABAMA. HENRY COUNTY: sand hills 6.5 mi. s. Abbeville on US 431, 24 July 1968, *Kral* 31951; sandy oak-pine woods 1.5 mi. s. Abbeville on US 431, 24 July 1968, *Kral* 31966.

Perdue (Rhodora 59: 1957), reports this species as from southeastern Georgia and northeastern Florida, but not from Alabama. In the field quite similar from a distance to *R. hirta,* but paler green because of the soft, long, clammy, spreading pubescence of stem and leaves, and because of the paler yellow rays.

Ratibida columnifera (Nutt.) Woot. & Standl.

R. columnaris (Sims) D. Don

ALABAMA. LOWNDES COUNTY: chalk prairie by US 80, 3.2 mi. w. Lowndesboro, 28 June 1970, *Kral* 39807.

Appearing to be a recent introduction to Alabama. At this locality it was extremely abundant, the population showing a great range of ligule pigmentation from deep maroon to yellow or orange. It appears well established, in a locality strikingly similar to the western calcareous prairies where this ratibida is sometimes weedy. This part of Alabama is cattle country, so that akenes of the species could have been brought in either with shipments of stock or feed.

Bidens cernua L.

ALABAMA. LIMESTONE COUNTY: 5 mi. n. Dekatur by US 31; abundant on wet gravelly creekbank, 16 October 1969, *Kral* 37860.

An extension southward from Tennessee.

Bidens tripartita L.

ALABAMA. LIMESTONE COUNTY: north of Dekatur across reservoir of Tennessee River at Wheeler Wildlife Refuge; silt of drying bottoms, 22 September 1970, *Kral* 41207.

An extension southward from Tennessee.

Viguirea porteri (A. Gray) Blake

ALABAMA. CHAMBERS COUNTY: granite outcrop area 1.9 mi. n.w. Penton, 17 Oct. 1969, *Kral* 37889.

This representative of a southern and southwestern north American genus has already been reported for Alabama by Harper and later by McVaugh (Ecol. Monogr. 13, no. 2, 1943). The Chambers County locality is however an additional county record in Alabama for this rather restricted endemic.

Marshallia mohrii Beadle & Boynt.

ALABAMA. CHEROKEE COUNTY: peaty seepage area by Ala. 9, 6 mi. s. Centre, 21 July 1968, *Kral* 31739; sandy clay of savanna pasture swale, ca. 6 mi. s. Centre by Ala. 9, 5 June 1969, *Kral* 35018.

The above two collections represent flowering and fruiting material from a very large population. The find is here

considered noteworthy in that Dr. Channell (Contrib. Gray Herb. CLXXXI, 1955) mentions in his revision that the last known collection of this rare species was made at the type locality in Cullman, Alabama in 1941 and that no current stations for it were presently known to him.

Artemisia ludivociana Nutt.

TENNESSEE. RUTHERFORD COUNTY: clearings in cedar glades by Percy Priest Lake, n. of Luvergne, 3 October 1969, *Kral* 37511.

Reported by Sharp *et al.* (*op. cit.*) from the Great Smoky Mountain National Park Headquarters and as a probable escape in Hardeman County. However appearing well naturalized in the cedar glades. An extension eastward from the western prairie districts, or southward from Illinois.

Cacalia diversifolia T. & G.

Mesadenia diversifolia (T. & G.) Greene

ALABAMA. HOUSTON COUNTY: 5.5 mi. s.e. Cottonwood, near creek on floodplain of Cowarts Creek, 24 May 1967, *McDaniel* 9059; ca. 2 mi. s.w. Cottonwood in creek bottom, 8 June 1968, *Kral* 31321; Cowart's Creek bottoms ca. 6 mi. s.e. Cottonwood, 8 June 1968, *Kral* 31317.

Proper credit for the find must go to Dr. McDaniel who told me of the locality. Formerly, the species was thought to occur only at a few isolated points in Florida. The Chipola River of Florida along which it is locally abundant, heads up in Alabama partly as Cowart's Creek.

Hypochaeris glabra L.

ALABAMA. MONTGOMERY COUNTY: calcareous pasture and adjacent railroad embankment n.w. side Montgomery by US 31, 28 April 1969, *Kral* 34572; heavy soil of motel lawn, by Loop, s. side Montgomery, 1 June 1970, *Kral* 39584.

This representative of a mainly South American genus, has been reported, in the southeast, from North and South Carolina; it appears to be abundant locally in the cal-

careous areas about Montgomery and is to be looked for throughout the black belt. Well established in the Pacific states.

Lactuca saligna L.

TENNESSEE. CLAY COUNTY: shaley banks by Tenn. 52, ca. 2 mi. s. Celina, 11 August 1970, *Kral* 40430. MARION COUNTY: steep limestone roadbank by US 41, ca. 4 mi. s.s.e. Monteagle, 7 October 1969, *Kral* 37630. WILLIAMSON COUNTY: elm dotted calcareous meadow by I-65, 0.5 mi. n. jct. Tenn. 96 (Franklin turnoff), 3 October 1968, *Kral* 33530.

An extension southward from Kentucky for this weed.

Taraxacum laevigatum (Willd.) DC

T. erythrospermum Andrz. ex. Besser

ALABAMA. DALLAS COUNTY: 2 mi. s.e. US 80 crossing of Alabama River at Selma; banks of highway above wet ditch, 15 April 1970, *Kral* 38575.

Not previously reported for Alabama; at scattered locali- in the southeastern United States.

DEPARTMENT OF BIOLOGY
VANDERBILT UNIVERSITY
NASHVILLE, TENNESSEE 37203

ADDITIONS TO THE BAHAMA FLORA SINCE BRITTON AND MILLSPAUGH — I.

William T. Gillis, Richard A. Howard,
and George R. Proctor

Additional taxa may be found in a region covered by a flora if (1) they were overlooked by the original flora writers, (2) they were described since the flora was completed, (3) they have been segregated from other taxa in the meantime, or (4) they have been introduced since the flora was completed. We compile here 81 taxa of vascular plants which are added to the Bahama flora since the publication of Britton and Millspaugh's work (1920). Some are reported for the first time; others are cited as having been gleaned from the diffuse taxonomic literature as it relates to the Bahama flora. Three previous works are of principal concern. A check-list of the plants of Bimini was published in connection with vegetational studies there (Howard, 1950). Additions to the flora of Inagua, the southernmost island in the archipelago, were noted by Howard and Dunbar (1964). Still other plants, not previously recorded by Britton and Millspaugh, were pointed out for Grand Bahama Island and Eleuthera (Lewis, 1971).

We present here, in the process of preparing a new vascular flora of the Bahama Islands, a compilation of additional vascular plants, growing without cultivation, in the Bahama Islands including the Turks and Caicos group. We include the Turks and Caicos Islands in the Bahamas, as did Britton and Millspaugh, because they all comprise the same geographical unit, despite the fact that the Turks and Caicos Islands are a separate Crown Colony from the Commonwealth of the Bahama Islands. A second paper on additional species is in preparation, the result of a recent study in the southern islands by Gillis and Proctor. Another paper will follow, summarizing nomenclatural changes from usage in Britton and Millspaugh. Together,

these papers should represent the indigenous Bahamian flora as it is now understood.

Voucher specimens for plants reported here for the first time are deposited in the herbaria of the Fairchild Tropical Garden (for specimens of Gillis and John Popenoe), of the New York Botanical Garden (for specimens of Howard), and of the Institute of Jamaica (for specimens of Proctor), with duplicates at the Arnold Arboretum.

POLYPODIACEAE

Trismeria trifoliata (L.) Diels. This species was found on the cay Lubbers Quarters off Marsh Harbour, Great Abaco (*Gillis* 7328A and *Popenoe* 131). It occurs on marl fill over an old *Conocarpus* swamp at the south end of the island, possibly introduced with the fill.

Pteris vittata L. This species was also found in the same marl fill as the *Trismeria* above (*Gillis* 7323 and *Popenoe* 132), on a road cut near Marsh Harbour (*Proctor* 30554), and on Grand Bahama Island near the former town site of Freeport, abandoned about 1954 (*Gillis* 7841).

NAJADACEAE

Najas marina L. This species is not reported by Clausen (1936) as occurring in the Bahamas. Its having been found in the Duck Pond on South Bimini, the island nearest to the Florida mainland, is however not surprising. It most likely has been brought in from Florida and may now spread by birds to other islands in the chain. This species represents a new family of flowering plants for the Bahamas (*Gillis* 11289).

GRAMINEAE

Cenchrus gracillimus Nash. This species is reported from Fortune Island (now known as Long Cay) in the monograph by DeLisle (1936), represented at the Missouri Botanical Garden by an old Hitchcock collection.

Eragrostis ciliaris var. *laxa* Kuntze. Hitchcock (1936) from Grand Turk and South Caicos.

Eragrostis excelsa Griseb. A pan-Caribbean species reported by Howard (1950) from a cemetery in Bimini.

Eragrostis urbaniana Hitchc. in Urb. Hitchcock (1936) from South Caicos, Long Cay (Caicos), and Grand Turk. This species was included in *E. ciliaris* in Britton and Millspaugh. It is represented by a recent collection (*Proctor* 9194) from Grand Turk.

Monanthochloë littoralis Engelm. Howard (1950) from Mosquito Point, North Bimini.

Panicum echinulatum Mez. *Proctor* 8955 from South Caicos. Hitchcock (1936) indicates that the species has been introduced to the West Indies from Paraguay and Bolivia.

Paspalum bakeri Hack. Collected on Abaco from the Eastern Shore District (*Proctor* 30734), this species was also reported from Inagua by Chase (1929).

Paspalum laxum Lam. Howard (1950) from old fields on Bimini.

Paspalum molle Poir. *Proctor* 30564 from Marsh Harbour, Abaco.

Paspalum propinquum Nash. Chase (1929) from Inagua.

Paspalum urvillei Steud. *Proctor* 30621 from seven to eight miles southwest of Marsh Harbour, Abaco.

Rhyncheletrum repens (Willd.) Hubb. Reported as *R. roseum* from Eleuthera by Lewis (1971), and found by Gillis on New Providence, Abaco, and Exuma. This weed of the southern United States, a native of Africa, has become common in the southeastern United States within the last 50 years. It surely would not have been overlooked by Britton and Millspaugh if it had been present prior to 1920.

Setaria geniculata (Lam.) Beauv. Howard (1950) from old fields on Bimini.

Sorghum halepense (L.) Pers. *Proctor* 30624 from Abaco, where it is extensively naturalized.

CYPERACEAE

Cyperus aristata Rottb. Both Horvat (1941) and McLaughlin (1944) cite specimens of this species from the Bahamas in their revisions of certain groups of *Cyperus*.

Cyperus globulosus Aubl. Reported (as *C. globosus*) by Howard (1950) from old fields on Bimini.

Eleocharis geniculata (L.) R. et S. Stimson (1967) from Bimini.

Fimbristylis annua (All.) R. et S. Kral (1971) records this species from Andros and New Providence.

Fimbristylis autumnalis (L.) R. et S. This species was cited by Kral (1971) as inhabiting the "Caribbean Islands" with no specific reference to the Bahamas. *Proctor* 30811 confirms its presence at Morgan's Bluff, North Andros.

PALMAE

Coccothrinax inaguensis Read. This palm was described as new by Read (1966) as a segregate from *C. argentata.* It was described initially from Inagua but has since been found on San Salvador, along the shore near Sandy Point (*Gillis* 8796 and *Popenoe s.n.*). Presumably it is on other southern islands in the chain as well.

Phoenix dactylifera L. Proctor has seen this escaping from cultivation in the Caicos group.

JUNCACEAE

Juncus roemerianus Scheele. Presence of this plant adds another plant family to the Bahama flora. Specimens have been collected by Peter Garrett near Red Bays, North Andros, and sent to the Fairchild Tropical Garden herbarium for identification. *Proctor* 30515 records its presence on Abaco, about 8 miles southeast of Marsh Harbour.

LILIACEAE

Smilax domingensis Willd. *Proctor* 9082 from North Caicos. Britton and Millspaugh state that Hitchcock's material determined as this species actually represents *S. havanensis.* The present assignment of the North Caicos material to this species must, therefore, be viewed with doubt, although the Proctor specimen resembles *S. domingensis* much more than *S. havanensis.*

DIOSCOREACEAE

Dioscorea bulbifera L. Found as a weed on the north side of New Providence Island in a coppice (*Gillis* 7520).

IRIDACEAE

Sisyrinchium exile Bicknell. Reported from Inagua by Howard and Dunbar (1964), a presumed waif. Daniel B. Ward (personal communication) suggests that this species may actually be the same as *S. micranthum* Cav.

PORTULACACEAE

Talinum triangulare (Jacq.) Willd. Determined by Howard from material sent in from the Exuma keys where it had some use in bush medicine. Reported as introduced and naturalized at Red Bays on North Andros (*Proctor* 30887) and at the Current on Eleuthera (*Proctor* 30952).

NYCTAGINACEAE

Bougainvillea glabra Choisy. Howard (1950) reported this species as persistent after cultivation on Bimini. It is not known to produce seed in the Bahamas, and therefore probably does not escape from cultivation.

PHYTOLACCACEAE

Phytolacca purpurascens A.Br. et Bouché. Lewis (1971) reported this species from Grand Bahama Island. *Gillis* 7385 is from bulldozed marl about 15 miles north of Marsh Harbour, Abaco. (The Gillis specimen determined by Jonathan Sauer whose assistance is gratefully acknowledged.)

AIZOACEAE

Sesuvium microphyllum Willd. This West Indian species was collected on Grand Turk (*Proctor* 8808). More recently, it has also been confirmed from a dry pond near Matthew Town, Inagua (*Gillis* 11707).

PAPAVERACEAE

Bocconia frutescens L. This species was first noted on Abaco by a local naturalist, Jack Patterson. It was collected and identified for inclusion in the Bahama planting at the Fairchild Tropical Garden where it has not been successful. (*Gillis* 7395 and *Proctor* 30599 from the same locality.) The occurrence of the plant is very local, extending along the road and into the pine woods for about a mile,

15 miles north of Marsh Harbour. It is obviously doing well and becoming locally abundant. So far as is known, this is its only station in the Bahamas.

CRUCIFERAE

Lepidium filicaule C.L. Hitchc. Described as new by Hitchcock (1945) from specimens determined by Britton and Millspaugh as *L. virginicum,* presumably depauperate ones. It is known from rocks on the east shore of Ambergris Cay in the Caicos group, and from South Caicos.

LEGUMINOSAE

Acacia tortuosa (L.) Willd. Represented by a specimen (*Lewis, s.n.*) at the Institute of Jamaica. It is interesting that this species should be reported as new to the Bahamas inasmuch as it has only recently been reported as new to South Florida (Alexander, 1968).

Caesalpinia divergens Urb. Howard (1950) reports this plant (as *Guilandina divergens*) from Bimini where it inhabits coastal thickets.

Lonchocarpus sericeus Kunth. This plant was collected by John Popenoe at South Beach, New Providence in a seemingly wild state even though it is difficult to suspect any place so close to Nassau as not having been in cultivation. Seed from this population has grown to plants of mature, bearing age at the Fairchild Tropical Garden. Specimens from this cultivated population have been determined by Mr. Mario Sousa at Harvard University. This is a West Indian species which could easily be in the Bahama flora; its having been found only once in the middle of the island chain is, however, puzzling.

Melilotus alba Desr. Naturalized in old fields seven to eight miles southwest of Marsh Harbour, Abaco (*Proctor* 30609).

Stylosanthes tuberculata Blake. In his revision of the genus *Stylosanthes,* Mohlenbrock (1957) reports this species from Southwest Landing on New Providence.

Stylosanthes calcicola Small. Mohlenbrock (ibid.) also reports this species from New Providence where it has been collected at West Bay.

RUTACEAE

Citrus aurantium L. Howard (1950) records this plant as escaped from cultivation on Bimini.

Zanthoxylum bifoliolatum Leonard. Discovered on San Salvador by John Popenoe. It has been found at the southwest corner of the island near the Sandy Point House (erroneously called "Watling's Castle") and from the dirt road that leads from near Rocky Point to Great Lake (*Gillis* 8811). Indigenous to Hispaniola, its occurrence on the eastern fringe of the Bahama archipelago 500 miles from Hispaniola is puzzling, but it is not the only species to have this distribution (see *Croton discolor*). One of the authors (GRP) prefers use of the generic name *Fagara*, but the other two have chosen to follow Brizicky (1962).

Spathelia bahamensis Marie-Victorin. Described by Marie-Victorin (1948) as a new species, endemic to the Bahamas. The type came from a point northwest of Settlement, Cat Island. *Proctor* 30973 confirms its occurrence on Eleuthera, south of Rock Sound and 1 mile north of the entrance to the Cotton Bay Club. This species was included within *S. vernicosa* by Britton and Millspaugh.

MELIACEAE

Cedrela odorata L. Known from the wild in a limited area on North Eleuthera near the settlements of Bluff and Upper Bogue (*Jack Patterson, s.n.*).

EUPHORBIACEAE

Croton discolor Willd. *Gillis* 8729 from a ridge on the southwest corner of San Salvador where it was growing with *C. linearis* which it resembles. Their differences were evident when seen together. *Gillis* 6205 (deposited at Michigan State University) is from near Graham's Harbour, also on San Salvador. This species was under consideration by Britton and Millspaugh, but all the material which they saw in this complex was considered to be *C. linearis*. These San Salvador collections confirm the presence of this species in the Bahamas.

Poinsettia cyathophora (Murr.) Kl. et Gke. This plant

may possibly be the species referred to by Britton and Millspaugh as *P. heterophylla*. Burch (1966) has pointed out that these two species have long been confused, but that *P. cyathophora* has red markings on the bracts and *P. heterophylla* has white markings. In any event, this ruderal plant is found on various islands, but true *P. heterophylla* has been collected thus far only from Bimini (*Gillis* 11308).

ANACARDIACEAE

Spondias purpurea L. Howard (1950) reports this species as escaped from cultivation on Bimini.

CELASTRACEAE

Maytenus phyllanthoides Benth. Jack Patterson of Abaco sent this species for determination. It appears to be a new record for the Bahamas of a shrub indigenous to the Florida Keys. It is probably more common than indicated, having been mistaken for *M. buxifolia* which is already known for the flora.

RHAMNACEAE

Colubrina asiatica (L.) Brongn. var. *asiatica*. Johnston (1971) shows Andros Island as having this species according to his dot map, but does not specifically cite specimens from the Bahamas. A recent collection (*Gillis* 11680) has been made from the strand on the southwest shore of Inagua. This Asiatic species has been known from the West Indies since 1860. Because of its habitat as a strand plant and because of its viability in sea water, it can be expected to appear more frequently in the Bahamas.

MALVACEAE

Cienfuegosia yucatanensis Millsp. Regarded as weedy in Cuba and Puerto Rico, Howard and Dunbar (1964) reported it first in the Bahamas from Inagua as *C. heterophylla*. Fryxell (1969) has recognized this to be *C. yucatanensis*.

Hibiscus acetosella Welwit. ex Hiern. This species was found growing without cultivation near a garbage dump on the east shore of the lake near Lake City, Abaco. It

may not persist, considering where it was found, but it nevertheless was healthy at the time of collection (1969), and appeared to be spreading (*Gillis* 7450). We are herein using the nomenclature of Bates (1965).

TURNERACEAE

Piriqueta caroliniana (Walt.) Urb. This species is common on some of the islands, but can become exceedingly difficult to find if a flush of flowering is past. It was abundant one day and nearly invisible the next day at the same site, once the bright yellow flowers had closed and/or fallen. Now known from Abaco (*Gillis* 7426) in a sandy swale south of the Marsh Harbour airport, Great Exuma (*Gillis* 9383) from roadsides north of Georgetown, and on the former townsite of Freeport, Grand Bahama Island (*Gillis* 7848). Ornduff (1970) had previously reported it as absent from the Lesser Antilles or Bahamas.

Piriqueta tomentosa Kunth. Found four miles west-northwest of Marsh Harbour, Abaco (*Proctor* 30434-A). In the same place, the glabrous form also was found (*Proctor* 30434, 30448). The latter is treated by some as *P. viridis* Small, but by others as only a glabrous form of *P. tomentosa* (Ornduff, 1970).

CACTACEAE

Harrisia undata (Pfeiff.) Britt. Proctor has collected this species on Grand Turk. His specimen fits the description of this Cuban species fairly well, with the exception that the hairs of the bud-scales are longer and more abundant, and the spines on the average are somewhat fewer than those of the Cuban plant. Britton's type specimen, however, was from cultivated material, and the process of cultivation may have produced modifications of these epidermal characters. On the other hand, the Grand Turk plant may represent a geographical race differing in these characters.

COMBRETACEAE

Terminalia muelleri Benth. This Australian native has been planted occasionally in Florida and the West Indies.

It has been found, apparently escaped from cultivation, on Eleuthera (*Proctor* 30913).

UMBELLIFERAE

Oxopolis filiformis (Walt.) Britt. From Abaco, 8 miles southwest of Marsh Harbour (*Proctor* 30463).

Hydrocotyle umbellata L. From Morgan's Bluff, North Andros (*Proctor* 30812). The old record of Dolley was disallowed by Britton and Millspaugh, and the species was thus excluded from the flora. The species, however, is now definitely confirmed from the Bahamas.

OLEACEAE

Jasminum fluminense Vell. Howard and Dunbar (1964) record this plant from Inagua. Native to Brazil, it is now weedy in the West Indies.

GENTIANACEAE

Sabatia stellaris Pursh. Reported by Lewis (1971) from Eleuthera. In his treatment of the North American species of this genus, Perry (1971) has also indicated that the species is known from Grand Bahama Island and Abaco as well.

ASCLEPIADACEAE

Cynanchum graminifolium (Griseb.) Alain. Reported by Howard (1950) as *Metastelma graminifolium* from Bimini.

CONVOLULACEAE

Merremia tuberosa (L.) Rendle. *Gillis* 7350 from Abaco, on the west shore of the lake near Lake City in a garbage dump. *Gillis* 7860 from near the Colonial Research Institute compound on Grand Bahama Island in the vicinity of Freeport.

Ipomoea nil (L.) Roth. *Proctor* 30783 from south of the San Andros airstrip on North Andros.

VERBENACEAE

Callicarpa americana L. *Popenoe* 129 from Abaco, 6 miles north of the Hole-in-the-Wall at the south end of the island in a pineland. *Proctor* 30769 from thickets between

cultivated fields south of the San Andros airstrip on North Andros.

Clerodendrum speciosissimum Van Geert. This plant is known to escape from cultivation on roadsides near the Current, Eleuthera (Lewis, 1971).

LABIATAE

Micromeria bahamensis Shinners. Shinners (1962) felt that true *Micromeria brownei* (as treated in Bahama Flora) did not occur in the Bahamas. He set up three varieties of *M. brownei*, one from Jamaica, one from Cuba and Mexico, and one from the southeastern United States and Mexico. For plants with narrower leaf blades (4-6 mm vs. 5-20 mm) and short calyx teeth, he erected this new species, endemic to the Bahamas. He added that a later worker mght choose to make this species another variety of *M. brownei*. For the moment, we follow Shinners's treatment.

Satureja rigida Bartr. *Proctor* 30456 from Abaco, eight miles southwest of Marsh Harbour.

SOLANACEAE

Solanum eleagnifolium Cav. *Proctor* 30960 from Hatchet Bay Farms, Eleuthera. This attractive plant may well be in other of the western islands of the archipelago, since its native range includes the southern Florida Keys.

PLANTAGINACEAE

Plantago virginica L. Howard and Dunbar (1964) report this species from the flat land beyond Conch Shell Point on Inagua. More recently, Gillis and Proctor have found it at Smith's Thatch Pond on the southern coast of Inagua.

RUBIACEAE

Hedyotis nigricans var. *filifolia* (Chapm.) Shinners. *Gillis* 7838 from a ruderal site of Grand Bahama Island. Lewis (1971) reported the species from a similar locality. *Proctor* 30583 from Abaco, five miles west-northwest of Marsh Harbour.

Morinda citrifolia L. This East Indies native is now

widely naturalized in the West Indies. *Proctor* 8772 came from a comparatively remote sea-beach at the eastern shore of Grand Turk and thus believed to be a natural sea-borne introduction.

Spermacoce aspera Aubl. Lewis (1971) tentatively reported this species as present at the Current, Eleuthera. The stems were upright to 0.3 m, and the corollas white. A specialist might segregate a microspecies from Lewis's specimen, but for now, it is recognized as this species.

LYTHRACEAE

Rotala ramosior (L.) Koehne. Reported by Lewis (1971) from the edge of a sandy beach at Dead Man's Reef, 9 miles east-southeast of West End, Grand Bahama Island.

ACANTHACEAE

Stenandrium carolinae Leonard et Proctor ex Leonard. See Leonard, 1960. This plant is an apparent endemic to North Caicos. It is known only from the type collection (*Proctor* 9094).

COMPOSITAE

Ageratum conyzoides L. Johnson (1971), in his treatment of the genus *Ageratum,* reported two subspecies of *A. conyzoides* from the Bahamas, both widely scattered among the islands, but neither appearing on the same islands together. Subspecies *latifolium* is the *Ageratum latifolium* of Britton and Millspaugh, but the typical subspecies *conyzoides* is herein reported as new to the Bahamas.

Gaillardia pulchella Foug. This common species of southern United States was picked up by Howard (1950) as an escape on Bimini.

Flaveria bidentis (L.) Kuntze. The record from Inagua by Howard and Dunbar (1964) was the first of this South American species from the West Indies but specimens from the Institute of Jamaica indicate that it has since been collected on Puerto Rico as well.

Flaveria trinervia (Spreng.) C. Mohr. *Proctor* 30502

from Abaco, about 10 miles south of March Harbour; *Proctor* 30784 from Morgan's Bluff on North Andros. More recently, Gillis and Proctor have found it on Mayaguana.

Senecio confusus Britten. *Gillis* 6372 from a cemetery at Calabash Bay, Andros where it escapes from cultivation. It does so as well on the south side of New Providence and probably elsewhere near habitations.

Emilia javanica (Burm.) C. B. Robinson. It is not surprising that this weed in South Florida has turned up in the Bahamas. It has been collected on New Providence (*Gillis* 7303), Grand Bahama (*Gillis* 7827), Eleuthera (*Lewis* 7239), and Abaco (*Proctor* 30630). Its lavender-flowered relative, *E. sonchifolia,* more rare in South Florida, was reported by Britton and Millspaugh from the Bahamas.

Solidago sempervirens L. Howard (1950) reported this species from Bimini; Lewis (1971) from Grand Bahama. A population from Lake City, Abaco (*Gillis* 7351) has been determined by Dr. Gary Morton to be *S. sempervirens* var. *mexicana* (L.) Fern.

Youngia japonica (L.) DC. *Proctor* 30759 found as a weed at Marsh Harbour, Abaco. We suspect that this plant has been introduced since the publication of Bahama Flora. We herein are following the nomenclature of Vuilleumier, 1973.

LITERATURE CITED

Alexander, Taylor R. 1968. *Acacia choriophylla,* a tree new to Florida. Quart. J. Florida Acad. Sci. **31:** 197-98.

Bates, David M. 1965. Notes on the cultivated Malvaceae. I. *Hibiscus.* Baileya **13:** 56-130.

Britton, Nathaniel Lord and Charles Frederick Millspaugh. 1920. The Bahama Flora. New York Botanical Garden. New York, N.Y. (Reprinted 1962, Hafner Publishing Co., New York, N.Y.).

Brizicky, George K. 1962. Taxonomic and nomenclatural notes on *Zanthoxylum* and *Glycosmis* (Rutaceae). J. Arnold Arbor. **43:** 80-93.

CHASE, AGNES. 1929. The North American species of *Paspalum*. Contr. U.S. Natl. Herb. **28**: 1-310 + xvii.

CLAUSEN, R. T. 1936. Studies in the genus *Najas* in the northern United States. Rhodora **38**: 333-45.

DELISLE, DONALD G. 1963. Taxonomy and distribution of the genus *Cenchrus*. Iowa State Univ. J. Sci. **37**: 239-351.

FRYXELL, PAUL A. 1969. The genus *Cienfuegosia* Cav. (Malvaceae). Ann. Missouri Bot. Gard. **56**: 179-250.

HITCHCOCK, A. S. 1936. Manual of the grasses of the West Indies. USDA Misc. Publ. 243: 1-439.

HITCHCOCK, C. LEO. 1945. The Mexican, Central American, and West Indian *Lepidia*. Madroño **8**: 118-43.

HORVAT, SR. MARY LIGOURI. 1941. A revision of the subgenus *Mariscus* found in the United States. Contr. Biol. Lab. Catholic Univ. Amer. **33**: 1-147 + x.

HOWARD, RICHARD A. 1950. Vegetation of the Bimini Island group, Bahamas, B.W.I. Ecol. Monog. **20**: 317-49.

HOWARD, RICHARD A. and HENRY F. DUNBAR. 1964. Additions to the flora of Inagua, the Bahamas. Rhodora **66**: 6-15.

JOHNSON, MILES F. 1971. A monograph of the genus *Ageratum* L. (Compositae — Eupatorieae). Ann. Missouri Bot. Gard. **58**: 6-88.

JOHNSTON, MARSHALL C. 1971. Revision of *Colubrina* (Rhamnaceae). Brittonia **23**: 2-53.

KRAL, ROBERT. 1971. A treatment of *Abildgaardia, Bulbostylis*, and *Fimbristylis* for North America. Sida **4**: 57-227.

LEONARD, EMERY C. 1960. Acanthaceae americanae novae vel criticae. Wrightia **2**: 75-82.

LEWIS, WALTER H. 1971. Additions to the flora of the Bahama Islands. Rhodora **73**: 46-50.

MARIE-VICTORIN, FR. 1948. Le genre *Spathelia* (Rutacées) avec description de cinq espèces et d'une variété nouvelles. Contr. Inst. Bot. Univ. Montréal **63**: 14-48. Références et Notes, p. 76.

MCLAUGHLIN, ANNE DESMOND. 1944. The genus *Cyperus* in the West Indies. Catholic Univ. Amer. Biol. Studies No. 5, pp. 1-108 + viii.

MOHLENBROCK, ROBERT H. 1957 (appeared 1958). A revision of the genus *Stylosanthes*. Ann. Missouri Bot. Gard. **44**: 299-355.

PERRY, JAMES D. 1971. Biosystematic studies in the North American genus *Sabatia* (Gentianaceae). Rhodora **73**: 309-69.

READ, ROBERT W. 1966. *Coccothrinax inaguensis* — a new species from the Bahamas. Principes **10:** 29-35.

SHINNERS, LLOYD H. 1962. *Micromeria brownei* and its allies (Labiatae). Sida **1:** 94-7.

STIMSON, WILLIAM R. 1967. Additions to the flora of the Bimini Island group, Bahama Islands. Rhodora **69:** 60.

VUILLEUMIER, BERYL SIMPSON. 1973. The genera of Lactuceae (Compositae) in the Southeastern United States. J. Arnold Arbor. **54:** 42-93.

W. T. GILLIS AND R. A. HOWARD
ARNOLD ARBORETUM, HARVARD UNIVERSITY
CAMBRIDGE, MASS. 02138

G. R. PROCTOR, SCIENCE MUSEUM
INSTITUTE OF JAMAICA
KINGSTON, JAMAICA, B.W.I.

REVISION OF THE GENUS PONTEDERIA L.

Richard M. Lowden

This small group of emersed aquatics is comprised of five species which are distributed throughout the tropical, subtropical and temperate regions of the New World. The center of diversity of *Pontederia* occurs in Middle America where the two recognized subgenera perhaps originated. A similar morphology, geography, cytology and chemistry suggest that *Reussia* Endl. does not warrant generic status apart from *Pontederia.* Subgeneric status is selected for *Reussia* since the species comprise a natural but distinct phyletic unit within *Pontederia*

Pontederia is quite variable in habit and leaf shape. Individual species, *i.e. Pontederia cordata* L., have many leaf forms which have contributed to the creation of many unwarranted taxa and combinations in the past. This is partly attributed to the limited geographical scopes of previous taxonomic studies of the genus. It has been important to recognize that distinct species have a development of similar leaf polymorphisms throughout a wide geographical range. Also where it has been possible, floral and fruit characters are selected to elucidate the natural phyletic units that comprise *Pontederia.*

NOMENCLATURAL HISTORY

Over two centuries ago Linnaeus (1737a, b, 1754) described the genus *Pontederia.* More than a few attempts have been made to clarify the typification of the genus. In order to elucidate the past (and consequently the present) status of *Pontederia* it is necessary to examine the following chronology of historical events:

Linnaeus (1737a) — Synonymy of Morison as communicated by Gronovius is cited along with the generic description of *Pontederia,* translated as follows:
calyx: Spathe common, oblong, laterally dehiscing.
corolla: Connate, biparted, gaping. Upper lip erect, flat,

of 3 equal parts. Lower lip reflexed, 3 parted, segments equal.

stamens: Filaments 6, awl-shaped, of which [1 stamen] is situated on each segment of the lower lip of the fused corolla, the 3 remaining [stamens] are closed under the upper lip.

pistil: Ovary not completely rounded. Style simple, short. Stigma undivided.

perigone: Capsule [little box or encasement] ovate [inside], 3 compartments, 3-valved, 3-angled, 3-furrowed.

seeds: Not completely rounded, many.

Linnaeus (1737b) — Dedication of the genus to Julio Pontedera, with special reference to the American Pickerelweed, Maryland and Virginia, of Morison, Petiver and Plukenet. The genus *Carimgolo* of Malabar was mentioned.

Linnaeus (1753) — Three species of *Pontederia* were enumerated in the class *Hexandria:* (1) *P. ovata,* with ovate foliage, flowers in heads, *Narukila* of Rheed. mal., habitat Malabar; (2) *P. cordata,* with cordate foliage, flowers in spikes, with identical reference made of the *Hortus Cliffortianus,* habitat Virginia; (3) *P. hastata,* with foliage hastate, flowers in umbels, *Carimgola* of Rheed. mal., habitat India.

Linnaeus (1754) — Generic description is the same as that in the first edition (1737) except for the following additions (translated):

corolla: tubular.

stamens: inserted on corolla, of which 3 are awl-shaped, long, and inserted on the throat of the corolla tube; 3 remaining stamens attached at the base of the same tube. Anthers pointed inwards.

pistil: Ovary oblong, above receptacle. Style simple, *very short,* curved downwards.

perigone: Capsule [encasement] fleshy, conic, apex wide and bent inwards.

Adanson (1763) — *Narukila* was listed with reference to *Pontederia* L. [*Narukila* is a nomen confusum.]

Rafinesque (1808, 1830) — Established the genus *Unisema* from that element of *Pontederia* described by Linnaeus (1753) as *P. cordata*. ". . . L. [Linnaeus] positively says that the fruit of it [*Pontederia*] is *3 locular and many seeded* [Linnaeus; 1737a, 1754]. I observed . . . the singular one seeded fruit [of *P. cordata*] and established the genus [*Unisema*] . . ."

Farwell (1924, 1928) — "As defined by Linnaeus in the Genera [1754], this genus is restricted to his *P. hastata*, the only species named by him in the *Species Plantarum* that had a many-seeded, 3-celled capsule, as was pointed out by Rafinesque . . ."

Sprague (1924) — *Carimgola* (Linnaeus, 1737b) was not definitely cited as a synonym of *Pontederia* since locality, the Maryland and Virginia habitat, and synonymy references (Linnaeus, 1737 a,b) are of *P. cordata*. "Thus it is evident that in 1737 he [Linnaeus] gave the new generic name *Pontederia* to the species subsequently named by him *P. cordata*, and that he was uncertain whether *Carimgola* (*P. hastata*) was congeneric or not."

Fernald (1925) — "The description of the genus *Pontederia* in the 5th edition of the *Genera Plantarum* (1754) was a mixture based upon the 2nd and 3rd species of the *Species Plantarum;* but in general the name has been maintained by post-Linnaean botanists for the American *Pontederia cordata;* Linnaeus's 1st species, *P. ovata* ['a plant with 1 stamen'], clearly not belonging in the class *Hexandria*, being excluded as a member of the family Marantaceae, and the 3rd species, *P. hastata*, separated off as *Monochoria* Presl." ". . . in the 1st edition of the *Genera*, Linnaeus [1737a] gave the same mixed description as in the 5th [1754], the capsules 3-valved and many-seeded, but stated that the plant was communicated by Gronovius (from Virginia)."

It is apparent from his three species that Linnaeus (1753) accidentally assembled dissimilar taxa under *Pontederia*. Farwell (1924) and Fernald (1925) point out that *P. ovata* having 1 stamen obviously did not belong

in the class *Hexandria* which includes *P. cordata* and *P. hastata*. Taxonomists must examine more critically the 1st and 5th editions of the *Genera Plantarum* (Linnaeus; 1737a, 1754) to know if Linnaeus (1753) actually considered *P. cordata* or *P. hastata* as the "type" of the genus.

Rafinesque (1808, 1830) insisted that the genus *Pontederia* as described by Linnaeus (1737a, 1754) called for fruits "3 locular and many seeded." Thus, Rafinesque established his genus *Unisema* from the Linnaean *P. cordata* having 1-seeded fruits. Farwell (1924, 1928) adopted Rafinesque's decision.

Sprague (1924) and Fernald (1925) defended *P. cordata* as the intended "type" of the Linnaean *Pontederia* based on locality (the Maryland and Virginia habitat) and synonomy (Morison, Petiver, Plukenet and Gronovius) as presented by Linnaeus (1737 a,b, 1753, 1754). Fernald (1925) also appealed to established custom which until today treats *P. hastata* as the Asian *Monochoria* and *P. cordata* as the American *Pontederia*. This appeal has been enforced by "principal systematic botanists" such as, Pursh (1814), Nuttall (1818), Torrey (1824), Solms-Laubach (1883), Britton and Brown (1913), Sprague (1924), Fernald (1925), Schwartz (1927), Hitchcock and Green (1929), and Castellanos (1951). All have retained and reinstated *Pontederia cordata* L. as the type of the Linnaean *Pontederia*.

The interpretation by Rafinesque (1808, 1830) of the Linnaean generic description of *Pontederia* (1737a, 1754) was accepted beyond doubt by Sprague (1924) and Fernald (1925). Fernald openly admitted Rafinesque's interpretation that the *Genera Plantarum* (1737a, 1754) called for "capsules 3-valved and many-seeded" and therefore Linnaeus based his generic description on a mixture of the 2nd (*P. cordata*) and 3rd (*P. hastata*) species of the *Species Plantarum* (1753). Both Sprague and Fernald sought valid evidence (locality and synonomy) in the *Genera Plantarum* (1737a, 1754) for support of *P. cordata* as "type" ignoring the generic description of the

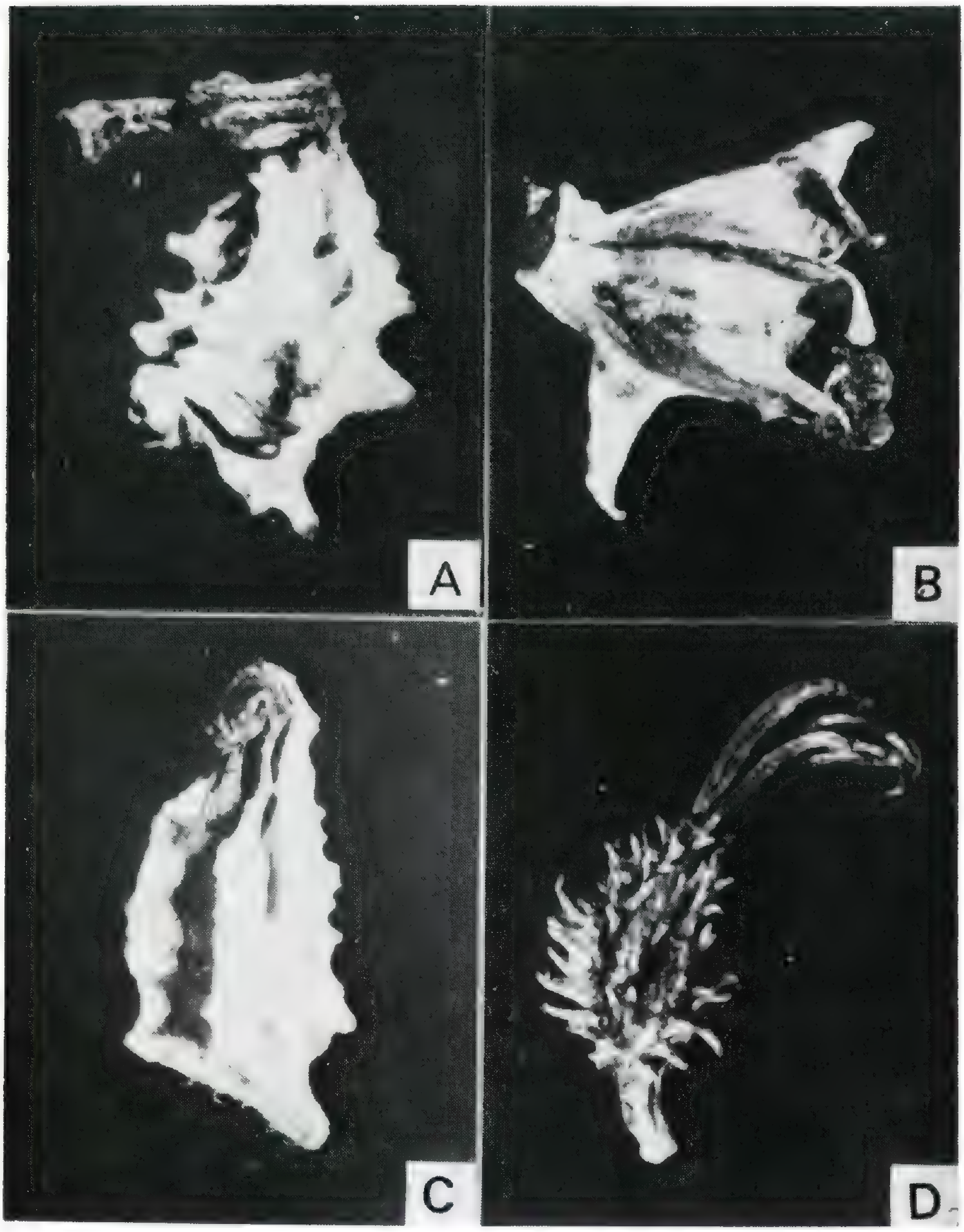


Figure 1. Hardened Perigone Bases of *Pontederia*. A. Tooth-ridged perigone of *P. cordata* var. *cordata*, U.S., Ohio (*Lowden*, 36, 37), 8 mm long. B. Smooth-ridged perigone of *P. sagittata*, Mexico (*Lowden* 6), 8 mm long. C. Tooth-ridged perigone of *P. parviflora*, Panama (*Lowden* 21), 8 mm long. D. Spinulose-ridged perigone of *P. rotundifolia*, Nicaragua (*Lowden* 17, 18), 10 mm long.

Linnaean protologue and the fact that it was misinterpreted by Rafinesque.

Rafinesque (1808, 1830) confused the modern terminology of "capsules 3-loculed and many seeded" (which actually applies to *P. hastata*) with the Linnaean choice of terminology in the *Genera Plantarum*. Linnaeus (1737a, 1754) used "capsula" to mean a "small box" or "encasement" and it was properly identified by him as part of the perigone (perianth). In general appearance the mature perigone of *P. cordata* (Fig. 1A) is triangular in all aspects and is rounded inside. Linnaeus never stated as Rafinesque insisted that the fruits were very many seeded, he only stated there were many seeds which implies without assumption each plant or inflorescence bears many seeds. This as does the rest of the generic description of the *Genera Plantarum* (1737a, 1754) fits perfectly *P. cordata* and can not be confused with the Asian *P. hastata* (*Monochoria hastata*). *Pontederia hastata*, with flowers actinomorphic, petals nearly free to the base (corolla not tubular), stamens 6 of which 1 is longer and seeds round, *can not possibly* be confused with the Linnaean *P. cordata*, with flowers zygomorphic, perianth 2-lipped, petals connate (tubular), stamens 6 of which 3 are longer and seeds not completely rounded. The additional wording of the 5th edition of the *Genera Plantarum* (1754) reveals that Linnaeus was describing the short style floral form (Fig. 3A, 3 stamens longer and a *very short* style) of tristylous *P. cordata*. The perigone encasement (capsule) was accurately described as fleshy, conic, with apex (Fig. 1A, mature stamens and upper portion of perigone) wide and bent inwards.

The Linnaean generic description of *Pontederia* (1737a, 1754) is exclusively that of *P. cordata* and not *P. hastata*. Linnaeus (1753) was sure of the morphological structure of *P. cordata* as it was explicitly expressed by him in the *Genera Plantarum*. Linnaeus accidentally included *P. ovata* and *P. hastata* in the *Species Plantarum* (1753) as he accidentally mentioned *Carimgolo* (= *P. hastata*) in his

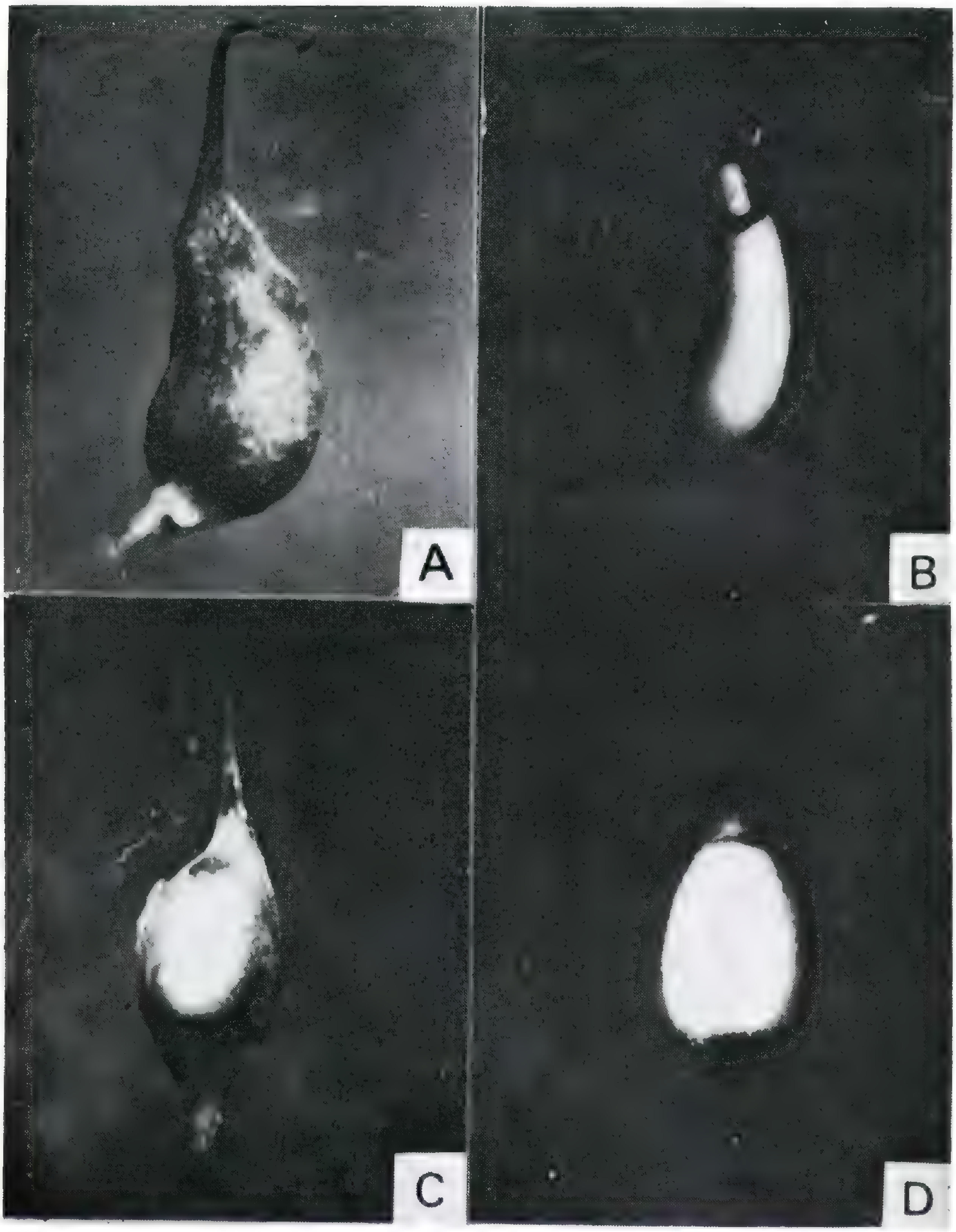


Figure 2. Fruits and Seeds of *Pontederia*. A. Utricle of *P. parviflora*, Panama (*Lowden* 21), 8.5 mm long. B. Portion of copious endosperm surrounding embryo of *P. parviflora*, Panama (*Lowden* 21), 4 mm long. C. Utricle of *P. rotundifolia*, Nicaragua (*Lowden* 17, 18), 8.5 mm long. D. Ovoid seed of *P. rotundifolia*, Nicaragua (*Lowden* 17, 18), 3 mm long.

Hortus Cliffortianus (1737b). It is difficult to understand why Linnaeus mentioned these taxa (perhaps they appeared superficially similar), since he made no mention of them in the generic description of the *Genera Plantarum.* This revision adopts *Pontederia cordata* L. as the lectotype of the Linnaean *Pontederia.*

In Solms-Laubach's treatment (1883) of the Pontederiaceae, *Pontederia* L. was recognized as being generally distinct from *Reussia* Endl. Both have one-seeded indehiscent fruits and two-lipped perigones (perianth). *Pontederia* was characterized by having 3 lobes in each lip, whereas, *Reussia* was characterized by having 5 lobes in the upper lip and 1 lobe in the lower lip. This was followed by Schwartz (1927, 1930), Schulz (1942) and Castellanos (1951, 1958). In accordance with this distinction, Castellanos (1951) transferred *Pontederia rotundifolia* L. f. to *Reussia* based on his reported observation of 5 lobes in the upper lip of the perigone.

My observations indicate that *Pontederia* species including *P. rotundifolia* have 3 lobes in each lip, even though the deepest incisions of the perigone occur on both sides of the smallest lobe of the lower lip. Contrary to later opinions, Endlicher (1836) described *Reussia* as having 4 lobes in the upper lip and 2 lobes in the lower lip. Certainly, the number of lobes in each lip is a confused and weak distinction for separating *Pontederia* and *Reussia.* Additional evidence obtained in the present investigation indicates that *Pontederia* and *Reussia* are so morphologically, cytologically and chemically similar as to warrant the treatment of *Reussia* (nom. cons.) as a subgenus of *Pontederia* in accordance with the *International Code* (1972, Appendix III, p. 284 and Article 14).

DISPERSAL MECHANISMS

Pontederia inhabits inland fresh waters and marshes transitional to salt waters along the coasts. It is primarily a genus of tropical and subtropical America, whose habitats are probably held in check by latitude (temperature)

and altitude (elevation). Mountain ranges, as exemplified by the Appalachian (Core, 1966) and Rocky Mountains in North America, the Sierras Madre Oriental and Occidental in Mexico, Sierras del Mico and Minas in Guatemala, Mayan Mountains in Guatemala and British Honduras, Cordillera Isabelia in Honduras, Cordillera de Talamanca in Costa Rica and the Andes in South America have been natural physiographic barriers promoting the speciation of *Pontederia* in the Americas. Geographical isolation is greatest among taxa within Middle America such as, *P. sagittata* (Fig. 16) and *P. parviflora* (Fig. 19).

Dispersal by water of *Pontederia* utricles is thought to be the main mode of long range dispersal, with vegetative reproduction a prominent factor in population establishment. The utricle is buoyant and consequently its distribution is due to the light aeriferous tissue of the perigone base (Fig. 1) surrounding it. Schulz (1942) reports a flotaion period longer than fifteen days for seeds enclosed in perigone bases which is long enough for the fruit to travel a considerable distance. The presence of fleshy perigone bases surrounding the utricles and the copious endosperm contained inside (Fig. 2B) greatly increase survival expectancy over long distances traveled.

Long distant dispersal of utricles (Fig. 2A, C) by avian and terrestrial animals (Sculthorpe, 1967) is considered to be of less frequent occurrence. Field observations of *Pontederia rotundifolia* at the Laguna Zapotitan, Dept. La Liberatad, El Salvador and in the fields of Lago Arenal, Province Guanacaste, Costa Rica suggest limited local terrestrial dispersal by animals. Both areas are inhabited by livestock on which the spinulose perigone bases (Fig. 1D) are easily anchored.

Vegetative reproduction by trailing prostrate branched stems and by rhizomes is of frequent occurrence throughout populations. Clones are recognized by clumping of plants within populations (Fig. 9). Rhizome fragmentation results in the establishment of new clones within close proximity. Field observations indicate that the prostrate

branched stems of *P. rotundifolia* with adventitious roots at each node may easily become severed and rooted. Trailing stems and rhizomes are able to survive harsh environmental pressures as organs of food accumulation during the climatic fluctuations of temperate and tropical regions.

TRISTYLY

Tristyly, as the term relates to *Pontederia*, is the type of heterostyly in which three kinds of plants occur in a species. These are (1) plants with flowers having a SHORT STYLE, 3 medium stamens and 3 long stamens (Sml); (2) plants with flowers having 3 short stamens, a MEDIUM STYLE and 3 long stamens (sMl); and (3) plants with flowers having 3 short stamens, 3 medium stamens and a LONG STYLE (smL. The Sml, sMl and smL floral forms (Fig. 3A-C) were found in *Pontederia cordata* (including varieties), *P. sagittata*, *P. rotundifolia* and *P. subovata*. Only *P. parviflora* has plants with 3 short stamens, 3 long stamens and a LONG STYLE (slL). The slL floral form (Fig. 3D) is an excellent diagnostic character for distinguishing this homostylous taxon from its closely related tristylous counterparts of subgenus *Pontederia*.

Legitimate pollinations (Fig. 4, pollen transfer from a stamen to the stigmatic surface of a pistil of equivalent length) are more productive of seeds than illegitimate pollinations (Fig. 4, pollen transfer from a stamen to the stigmatic surface of a pistil not the equivalent length). Ornduff (1966) demonstrated with *Pontederia cordata* that self-incompatibility (self and own-form pollinations are illegitimate) is "considerably stronger" in the smL and Sml floral forms than in the sMl floral form. Regarding legitimate pollinations the sMl floral form had a greater percentage seed production than the smL and Sml floral forms.

An indication of this breeding system of individual populations may be extrapolated through the study of the frequency of floral forms within populations of different *Pontederia* taxa (Table 1). In populations where all three

Table 1. Floral Form Frequency in Pontederia based on Population and Herbarium Studies[1]

Taxon	Populations & Vouchers	# (%) Inflorescences			
		Sml	sMl	smL	slL
P. cordata var. *cordata*	U.S. Ohio, Ottawa Co., Winous Pt. SW of Port Clinton, *Lowden* 36 & 37.	8(33.3)	5(20.8)	11(45.8)	—
	British Honduras, Belize District: 9 miles N of Belize City, *Lowden* 24;	5(62.5)	2(25.0)	1(12.5)	—
	29 miles N of Belize City, Cowhead Creek, *Lowden* 26;	0(0)	0(0)	3(100)	—
	32 miles N of Belize City, *Lowden* 27;	2(66.7)	1(33.3)	0(0)	—
	Hattieville Burrell Boom Road, 5½ miles from Burrell Boom, *Lowden* 28.	0(0)	2(40.0)	3(60.0)	—
var. *lancifolia*	U.S. Florida, Holmes Co., 0.2 miles E of Florida 81 in Ponce de Leon, *Stone* 2589 Sml, 2590 smL & 2591 sMl.	+	+	+	—
var. *ovalis*	Brazil. Mato Grosso, 300 km. past Cuiaba in route to Goiania, *Maguire et al* 56931 Sml; Brasilia,	+	+	+	—

[1]Code to floral forms: (Sml) SHORT STYLE, 3 medium stamens, 3 long stamens; (sMl) 3 short stamens, MEDIUM STYLE, 3 long stamens; (smL) 3 short stamens, 3 medium stamens, LONG STYLE; (slL) 3 short stamens, 3 long stamens, LONG STYLE. A plus sign (+) indicates the occurrence of the floral form, whereas a dash (—) indicates the floral form is unknown in the taxon.

Table 1. (cont.)

Taxon	Populations & Vouchers	# (%) Inflorescences Sml	sMl	smL	slL
	Federal District, *Prance & Silva* 59082 smL. Colombia, Dept. Boyaca, near Orocue, *Haught* 2716 sMl.				
P. sagittata	Mexico. State Vera Cruz: Vera Cruz, El Coyol, *Lowden* 6;	46(33.8)	52(38.2)	38(27.9)	—
	El Puente de Teculapilla, Carretera Nacional 180, 5 km. NW of Lerdo, *Lowden* 7;	5(55.6)	1(11.1)	3(33.3)	—
	Laguna Catemaco, Arroyo Agrio, *Lowden* 9.	10(76.9)	3(23.0)	0(0)	—
	Guatemala. Dept. Izabal: Quirigua, *Lowden* 10;	2(9.1)	12(54.5)	8(36.4)	—
	Puerto Barrios, *Lowden* 11	10(32.3)	14(45.2)	7(22.2)	—
	Honduras. Dept. Cortes: Puerto Cortes, *Lowden* 13;	0(0)	6(37.5)	10(62.5)	—
	13.5 miles inland from Puerto Cortes, *Lowden* 14.	16(47.1)	7(20.6)	11(32.3)	—
	Dept. Atlantida: Tela, La Curva, *Lowden* 15;	15(34.1)	16(36.4)	13(29.5)	—
	Santiago, 11 miles W of Tela, *Lowden* 16.	21(55.3)	12(31.6)	5(13.2)	—
P. parviflora	Panama. Province Herrera, Los Llanos de Santa Maria, *Lowden* 20;	—	—	—	89(100)

Table 1. (cont.)

Taxon	Populations & Vouchers	# (%) Inflorescences			
		Sml	sMl	smL	slL
	Province Panama, between Pacora and Chepo, *Lowden* 21;	—	—	—	83(100)
	17 herbarium specimens cited under specimens examined.	—	—	—	+
P. rotundifolia	El Salvador. Dept. La Libertad, Laguna Zapotitan, *Lowden* 23.	0(0)	0(0)	29(100)	—
	Honduras. Dept. Comayagua, Lago Yojoa, Pito Solo, *Lowden* 12.	0(0)	30(81.1)	7(18.9)	—
	Nicaragua. Dept. Granada, near Granada, *Lowden* 17, 18.	0(0)	1?(0.7?)	145(99.3)	—
	Costa Rica. Province Guanacaste, 1 km. from Arenal, 2 km. from Trenadora, *Lowden* 19.	184(100)	0(0)	0(0)	—
P. subovata	Paraguay, prope Concepcion, *Hassler* 7352 Sml; Brazil, Estado Minas, Mun. Ituiutaba, Loc. S. Terezuiha, *Marcedo* 3168 sMl; Argentina, Prov. Chaco, Loc. Colonia Benitez, *Meyer* 3864 smL.	+	+	+	—

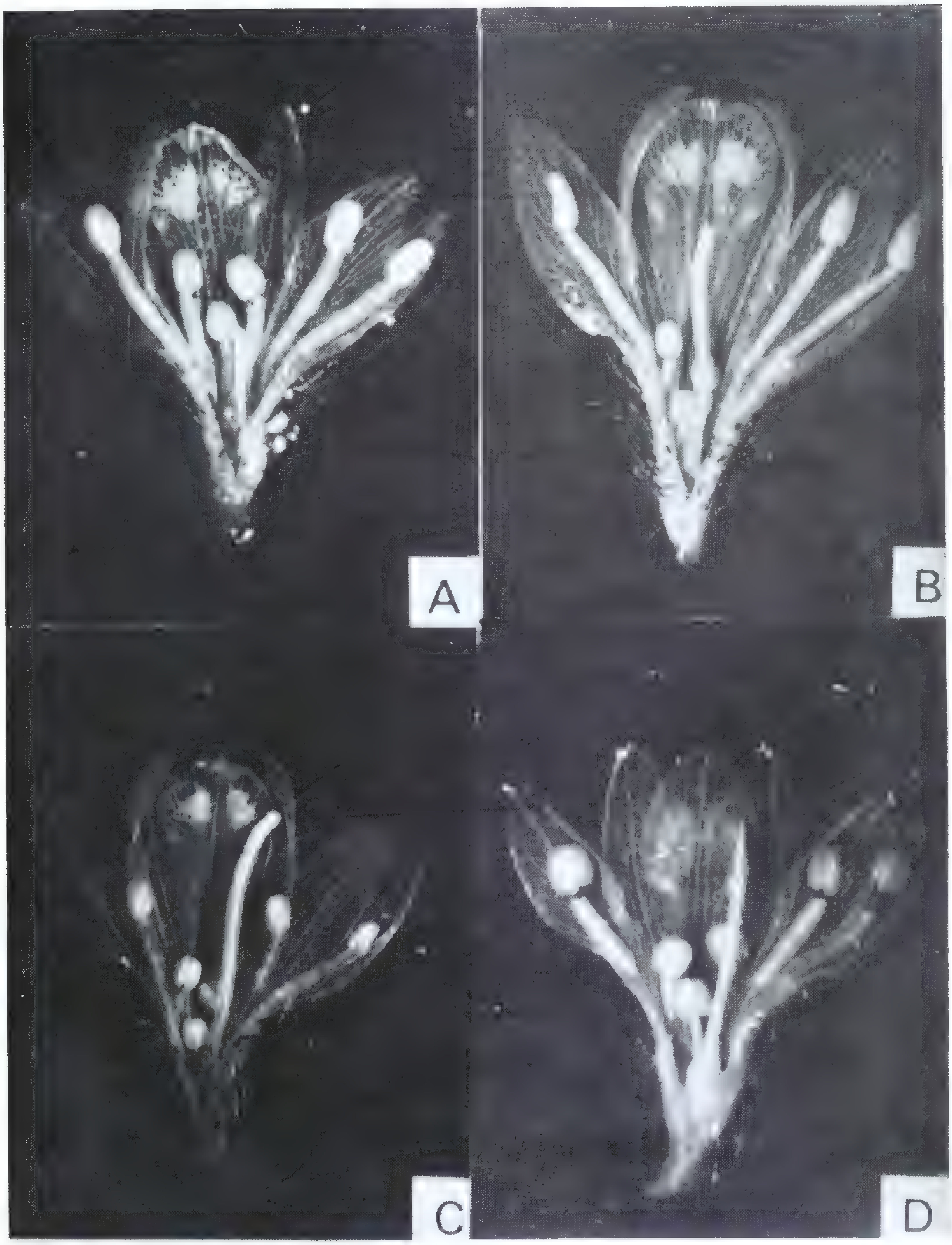


Figure 3. Floral Forms of *Pontederia*. A. SHORT STYLE, 3 medium stamens, 3 long stamens (Sml); *P. rotundifolia*, Costa Rica (*Lowden* 19), 10 mm long. B. 3 short stamens, MEDIUM STYLE, 3 long stamens (sMl); *P. rotundifolia*, Honduras (*Lowden* 12), 13 mm long. C. 3 short stamens, 3 medium stamens, LONG STYLE (smL); *P. rotundifolia*, Nicaragua (*Lowden* 17, 18), 11 mm long. D. 3 short stamens, 3 long stamens, LONG STYLE (slL); *P. parviflora*, Panama (*Lowden* 21), 7 mm long.

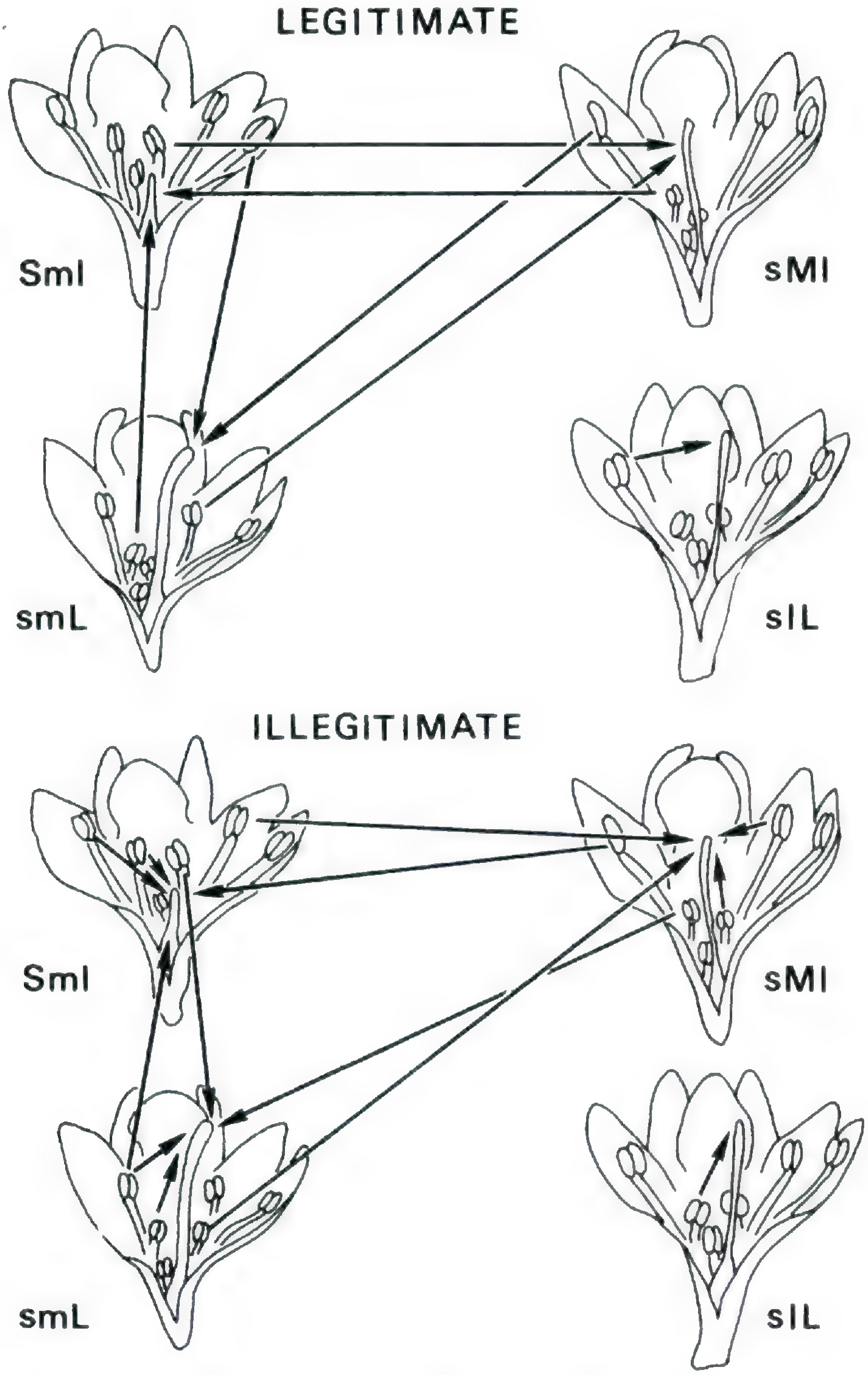


Figure 4. Legitimate and illegitimate pollinations in *Pontederia* floral forms (arrows represent the transfer of pollen from anthers to stigmas). See Fegure 3 for code to floral forms.

floral forms are present, it is difficult, only on the basis of frequency of occurrence, to know if any one floral form has greater breeding value compared with another floral form in the same population. However, in *Pontederia rotundifolia* three out of four populations examined (Table 1) had the frequent occurrence of one floral form in the absence of the other two (e.g., the smL floral form was found at Lago Nicaragua, Nicaragua and is absent at Lago Arenal, Costa Rica where the Sml floral form was found). These populations perhaps represent clonal establishment of a single floral form in which a certain amount of inbreeding must be occurring through illegitimate pollinations (selfing and own-form). Even though an incompatibility system is operative there is not total incompatibility in populations containing a single floral form.

The homostylous *Pontederia parviflora* has most likely been derived from a tristylous floral form. This is perhaps a step towards increased self-compatibility in one member of the genus. Field observations (in Panama) indicate a compatibility system due to the high seed set of infructescences.

In *Pontederia* a reproductive system has evolved which is highly tolerant to different pressures of the environment. Tristyly functions in juxtaposition with an effective mode of vegetative reproduction. Subgenus *Reussia* is characterized by having few flowered inflorescences (less seed production) and long trailing stems. Stem fragmentation, especially in populations having one floral form (*P. rotundifolia*), has greater immediate population survival value than reproduction through a tristylous breeding system. In subgenus *Pontederia,* inflorescences are many flowered (greater seed production), and the erect, above ground stems are much shorter. In this subgenus, tristyly perhaps has greater long range survival value and homostyly (*P. parviflora*) appears to be derived from a tristylous ancestor.

CYTOLOGICAL STUDIES

Smith (1898) recorded n=8 and $2n$=16 for *Pontederia*

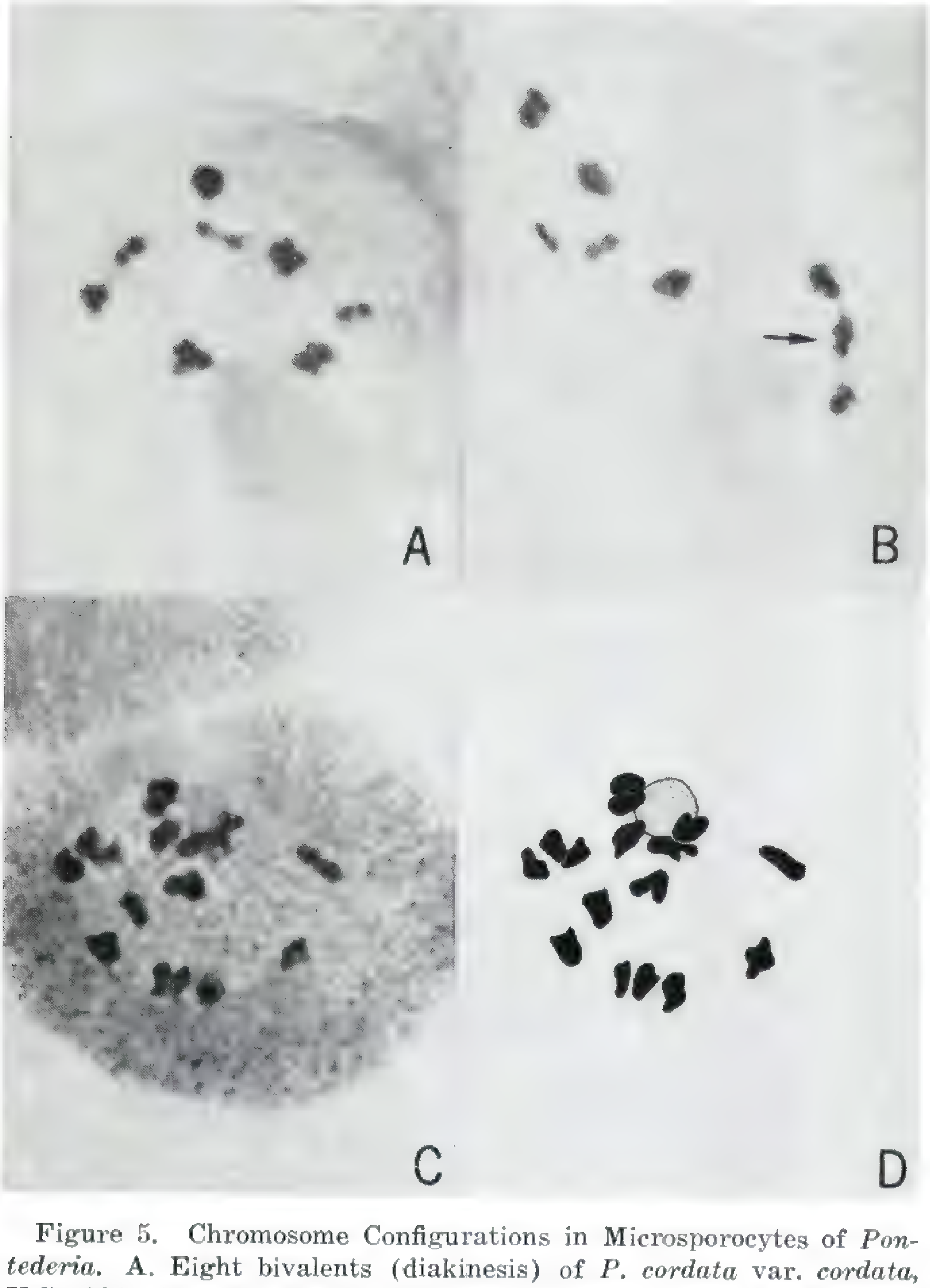


Figure 5. Chromosome Configurations in Microsporocytes of *Pontederia*. A. Eight bivalents (diakinesis) of *P. cordata* var. *cordata*, U.S., Ohio (*Lowden* 36, 37). B. Secondary association of six chromosomes (arrow points to three bivalents) of *P. cordata* var. *cordata*, U.S., Ohio (*Lowden* 36, 37). C. Sixteen bivalents of *P. rotundifolia*, Nicaragua (*Lowden* 17, 18). D. Diagramatic representation of C, showing sixteen bivalents of *P. rotundifolia*.

cordata. The cytological investigations of Bowden (1945) verified Smith's counts. This study reconfirms these earlier reports and elucidates counts (Table 2) for other *Pontederia* taxa.

Young *Pontederia* inflorescences still enclosed by the spathe and the petiole base of the flower stalk leaf were collected for microsporocytes undergoing meiosis. Inflorescences were placed in 100% ethanol and glacial acetic acid (3:1 respectively). After 24 hours, they were stored in 70% ethanol until anthers were stained with iron acetocarmine.

Microsporogenisis in taxa examined of subgenera *Pontederia* and *Reussia* is normal except for the occasional occurrence of secondary associations of either 4 or 6 chromosomes (Fig. 5B). Haploid counts (Table 2) during diakinesis (Fig. 5) indicate a base number of $x=8$ in *Pontederia.* Subgenera of *Pontederia* might be distinguished cytologically by the numbers, $n=8$ in subg. *Pontederia* and $n=16$ in subg. *Reussia.* The polyploid *P. rotundifolia* and possibly *P. subovata* (not examined) most likely evolved from an $n=8$ ancestor.

CHEMOTAXONOMIC STUDIES

Phenolic compounds, especially flavonoids, have recently been the subject of a large number of chemosystematic studies. These studies (Alston, 1967) have shown that color and position of phenolic compounds on chromatograms can be used to show systematic relationships without necessitating chemical characterization. Considering the validity of this empirical chromatographic data the following chemical studies were initiated in order to assess the degree of variation in phenolic patterns within and between taxa of *Pontederia,* to see if phenolic patterns of *Pontederia* taxa correlate with that indicated by morphology and geography, and to note if similarity in phenolic patterns exists between taxa of *Pontederia, Eichhornia* and *Heteranthera* (related genera).

The methods employed are essentially those outlined by

Mabry, Markham and Thomas (1970). Phenolic compounds were extracted from dried flower stalk leaf material in 50% aqueous-methanol for at least 24 hours before 4 ml of individual leaf extract were spotted on Whatman 3MM chromatographic paper. The two-dimensional solvent systems were: (1) 3 parts TBA : 1 part glacial acetic acid : 1 part distilled water and (2) 15% HOAc. Chromatographic patterns were read using no reagent in visible light, then in UV light with and without NH_3.

Twenty-six principal spots (Fig. 6) were discernible by position and color on chromatograms. Color characterizations (Table 3) were uniform throughout chromatograms, however, for spots with mixed color indications, it is possible that more than one phenolic compound is present. Spot numbers 11 and 15 (Fig. 6) were subdivided because color and close proximity of spots prevented contrasting delineations.

Summary phenolic patterns (Table 4) for each taxon were compiled using the total number of spots found in each taxon. Infrageneric and intergeneric comparisons of summary phenolic patterns were based on positive matches (a spot occurring in two taxa compared) and differences (a spot occurring in one of the taxa compared but not in the other). The degree of relationship between pairs of taxa was calculated using the coefficient of similarity $\frac{p}{p+d}$, where *p* represents the positive matches and *d* the differences. Coefficients vary from 0 (no resemblance) to 1 (identity).

Chromatographic patterns were subject to interpretation, although delimitations of infraspecific and interspecific taxa of *Pontederia* were not based strictly on phenolic patterns. Chromatograms were initially separated as to summary phenolic patterns (Table 4) in accordance with the morphological concept of taxa (see Taxonomy section). This morphological alignment of taxa was reinforced by the high coefficients of similarity (Fig. 7) obtained among taxa. The nine spots shared in common by all taxa of *Pontederia* examined (Table 4) are perhaps chemical

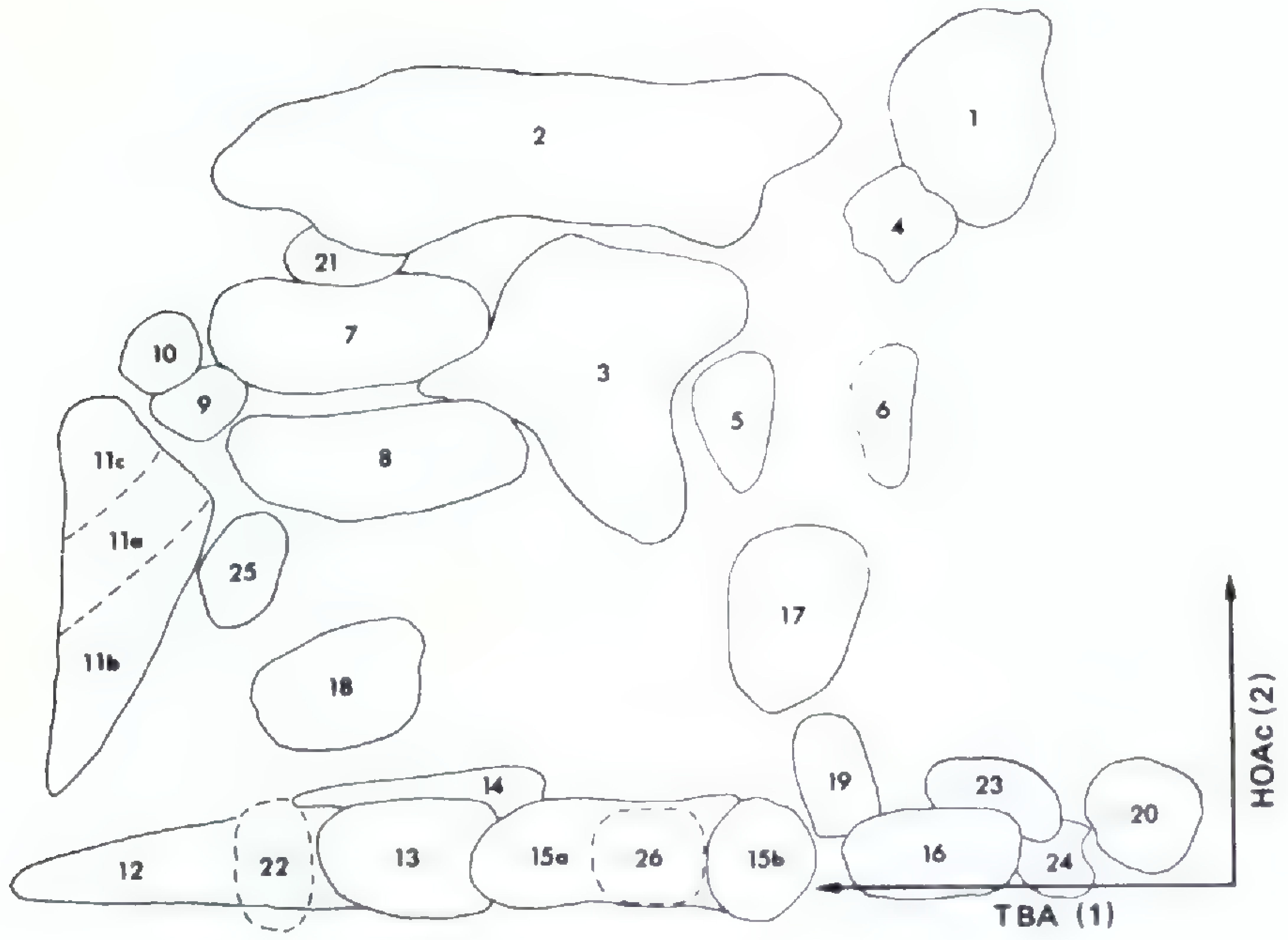


Figure 6. Summary two-dimensional paper chromatographic profile of phenolic compounds found in *Pontederia* and related genera.

indications of a similar operative genetics clearly visible by the close morphological identity among principal taxa.

Infrageneric comparisons (Fig. 7) indicate higher identity among typical *Pontederia cordata, P. sagittata, P. parviflora* and *P. rotundifolia* than among these taxa with *P. cordata* varieties *lancifolia* and *ovalis*. There was a stronger affinity of these two varieties with *P. rotundifolia* and *P. parviflora* than with typical *P. cordata*. This affinity should be tested further considering the very small sample sizes of varieties *lancifolia* and *ovalis* (Table 4).

High phenolic identity, greater variation in phenolic patterns, greater morphological similarity and like chromosome complement were found between typical *P. cordata* and *P. sagittata,* each containing an isolated spot (spot 15b and 22 respectively). Perhaps these single isolated spots are the development of metabolic pathways in fairly restricted geographical regions (Figs. 10-12, 15-16). The highest phenolic similarity was between *P. parviflora* and *P. rotundifolia*. Partial and fluctuating geographical isolation in Central and South America (Figs. 19, 22, 25)

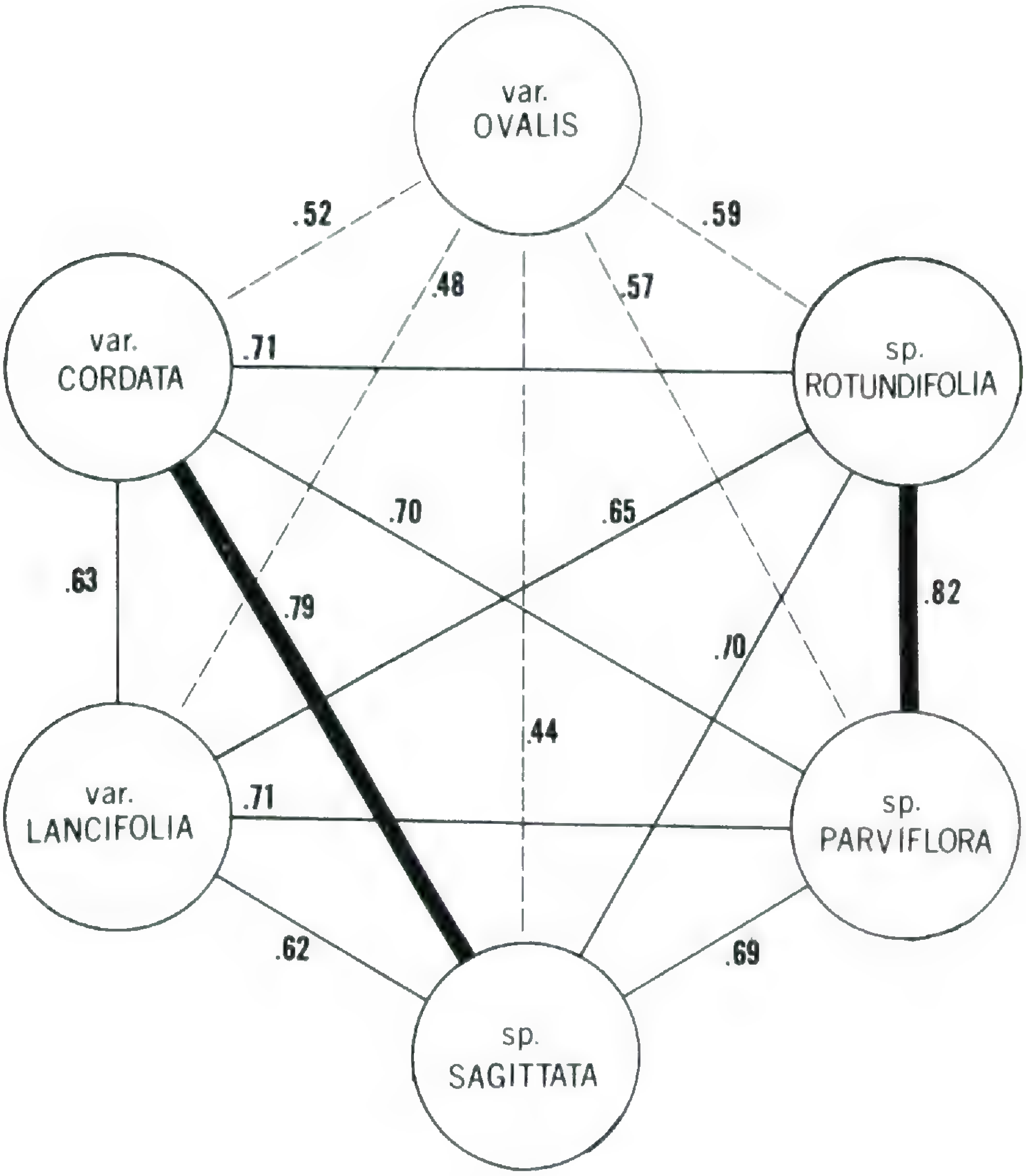


Figure 7. Graphic representation comparing two dimensional paper chromatographic profiles of *Pontederia* based on coefficients of similarity.

could account for a parallel and independent development or loss of metabolic systems in these two morphologically and cytologically distinct species.

Intergeneric comparisons of phenolic patterns and morphology reveal a greater difference between *Pontederia, Eichhornia* and *Heteranthera* than among taxa of *Pontederia.* Seven out of the nine spots common to *Pontederia* taxa were shared equally with *Eichhornia* and *Heteranthera* taxa examined. No spots (Table 4) were added to the total number of spots found in *Pontederia* by the inclusion of *Eichhornia* and *Heteranthera* taxa. Undoubtedly similar metabolic systems have evolved in the Neotropical Pontederiaceae, perhaps divergently from an ancestral system comparable with that found in typical *P. cordata* and *P. sagittata.*

EVOLUTIONARY CONSIDERATIONS

A speculative origin of *Pontederia* is attempted based on the present studies. The ancestral stock is hypothesized as aquatic, tropical in origin, inflorescence a many-flowered spike, fruit a one-seeded utricle, ovule pendulous, tristylous, six stamens, flowers zygomorphic and perianth parts basally connate. Cytological evidence indicates a haploid base chromosome number of $x=8$. Chromatographic patterns of phenolic compounds suggest that similar metabolic systems have evolved.

By the Lower Eocene, *Pontederia* had a restricted tropical range from South America to North America via the Middle American landbridge. On several occasions from the Upper Eocene to the Lower Pliocene (Schuchert, 1935) portions of Middle America were inundated. Speciation occurred in isolated areas as this isthmian landbridge rose and fell. Changes in environmental conditions (Baker, 1970), due in part to climatic instability and mountain building, were accompanied by floristic changes. A component of this change was *Pontederia* which persists today throughout Middle America.

Pontederia spread from Middle America into North

America where it had perhaps at one time a more western distribution as indicated by the Green River Formation of Eocene Age. *Pontederites* (Knowlton, 1922) was described from the lake margin fossil flora of the Green River Formation in northwestern Colorado and the Gosiute Lake in southwestern Wyoming. The fossil material is an upper portion of a leaf fragment which looks like the characteristic venation of living *Pontederia*. The Green River Formation was bordered on the north and west by the Rocky Mountains. The barriers were less containing to the east and south towards the Gulf Coastal Plain which was covered with water during the Eocene. As the water receded *Pontederia* was redistributed to the warmer subtropical climate of the Gulf Coastal Plain where it started to inhabit the Atlantic Coastal Plain of North America. The Appalachian Mountains (Core, 1966) were then and still are the main obstacle (Fig. 11) to its spread into the interior of the eastern United States.

The advent of the Pleistocene brought deleterious climatic changes resulting in a restricted southerly distribution of *Pontederia* toward the warmer climate of the Gulf Coast. As the climate fluctuated during glacial and interglacial periods, fluctuations also occurred in the distribution of *Pontederia* along the Atlantic Coast. Glacial withdrawal (Sculthorpe, 1967) brought an increasing warmth accompanied by an optimum post glacial maximum warmth, culminating in today's climatic conditions. The retreat of the last ice-sheets left behind numerous lakes, bogs and ponds. Since the Wisconsin glacier, *Pontederia* has spread and thrived throughout these aquatic glacial remnants of eastern North America reaching its present northern and northwestern limits within relatively recent times.

TAXONOMY OF PONTEDERIA L.

Pontederia L., Sp. Pl. 288. 1753. Gen. Pl. ed. 5, 140. 1754.
Lectotype: *Pontederia cordata* L.

Umsema Raf. [*Unisema* Raf., Med. Fl. 2: 105. 1830.], Med. Repos. II 5: 352. 1808.

Reussia Endl., Gen. Pl. 1: 139. 1836. Type: *Reussia triflora* Endl. ex Seub. = *Pontederia subovata* (Seub.) Lowden.

Perennial emersed herbs. Rhizomes branched, aerial stems erect or prostrate. Leaves obtuse; margins entire with parallel outwardly curved venation; blades (phyllodes) lanceolate, ovate, cordate, sagittate, hastate or reniform; foliage dark green to grayish, often containing anthocyanin. Petiole of floral shoot leaf short; petioles of other leaves long; bases sheathed and clasping, sheaths ligulate. Inflorescence a few to many flowered spike enclosed (early in floral development) by a spathe (the most terminal phyllode of the floral shoot) and petiole base of the flower stalk leaf; peduncles longest with maturation of infructescences and subtended by the spathe; sheath (expanded phyllode base) in axil of floral shoot. Flowers bisporangiate, zygomorphic (bilaterally symmetrical), bilabiate, blue to purple, white or white-green, largest perianth lobe with a bilobed yellow spot; perigone (perianth) of 6 basally connate parts; stamens 6 unequal, in two groups of 3 each, adnate to the perigone tube; anthers introrse, dorsifixed, versatile, dehiscing longitudinally; filaments and perigone tube covered with hairs terminated in pinheadlike glands; stigmas 3-lobed, each lobe bifid; tristylous or homostylous species; carpels originally 3, united, 2 aborted and 1 fertile, unilocular, 1-seeded; ovules pendulous, anatropous, placentation parietal. Fruit a utricle, 1-seeded, indehiscent; enclosed by a hardened perigone base, toothed, smooth or spinulose ridged; pericarp high in glutanous content. Seeds reniform or ovoid; endosperm white, copious, surrounding a cylindrical embryo.

Key To The Taxa

a. Hardened perigones toothed or smooth ridged (Fig. 1A-C); floral bearing shoots erect (subgenus *Pontederia*). . . . . *b.*

b. Style length unequal to stamen length (Fig. 3A-C) . . . . *c.*

c. Hardened perigones toothed ridged (Fig. 1A) .... *d.*

d. Leaves cordate, sagittate (unauricled), hastate or reniform .... la. *P. cordata* var. *cordata*

d. Leaves narrow to broadly lanceolate (leaf base not lobed) .... lb. *P. cordata* var. *lancifolia*

d. Leaves ovate to ovate-lanceolate (leaf base not lobed); peduncles hairy .... lc. *P. cordata* var. *ovalis*

c. Hardened perigones smooth ridged (Fig. 1B); leaves sagittate (usually deeply auricled) .... 2. *P. sagittata*

b. Style as long as the three longest stamens (Fig. 3D); leaves subcordate .... 3. *P. parviflora*

a. Hardened perigones spinulose ridged (Fig. 1D); floral bearing shoots prostrate (subgenus *Reussia*) ...... *e.*

e. Flowers long lasting (more than 8 flowers per inflorescence); leaves reniform, sagittate or cordate .... 4. *P. rotundifolia*

e. Flowers ephemeral (usually fewer than 12 flowers per inflorescence); leaves subovate, sublanceolate or elliptical .... 5. *P. subovata*

I. *Pontederia* subg. *Pontederia* (Lectotype: *Pontederia cordata* L.)

Hardened perigone bases toothed or smooth ridged (Fig. 1A-C); floral bearing shoots erect; aerial stems with short internodes; underground rhizomes long (mature plants).

Subgenus *Pontederia* is found 50° North to 35° South of the equator in the Americas.

1. *Pontederia cordata* L., Sp. Pl. 288. 1753.

Plants 9-13 dm tall. Leaves cordate, sagittate (unauricled), ovate or lanceolate; blades 0.4-21 cm wide; spathe (terminal phyllode of floral shoot) 2-7.4 cm long; petiole of floral shoot leaf (includes sheath base) 4-31 cm long; petiole of other leaves 28.7-59.5 cm long, ligule of petiole sheath 4-10.5 cm long; sheath in axil of floral shoots 22.3-

Figure 8. Inflorescence, clasping subtending spathe and flowering stalk leaf of *Pontederia cordata* var. *cordata,* U.S., Ohio, Ottawa County (*Lowden* photo, Jul 1966); upper figure.

Figure 9. Clones of *Pontederia cordata* var. *cordata* in marsh habitat, U.S., Ohio, Ottawa County (*Lowden* photo, Jul 1966); lower figure.

28 cm long. Inflorescence 2-16 cm long; peduncle (inflorescence base to floral shoot leaf base) 5-33 cm long. Perigone blue to white; hardened perigone bases (Fig. 1A) toothed ridged; anthers blue. Tristylous. Fruits and seeds reniform.

1a. *Pontederia cordata* L. var. *cordata*. Type missing: United States, Virginia and Maryland, communicated to Linnaeus by Gronovius. Neotype chosen: [Savage, 407.4] *P. Kalm* (LINN).

Umsema obtusifolia Raf., Med. Repos. II, 5: 352. 1808. Based on the type of *Pontederia cordata* L.

Umsema mucronata Raf., Med. Repos. II, 5: 352. 1808. Based on the type of *Pontederia cordata* L.

Pontederia angustifolia Pursh, Fl. Am. Sept. 224. 1814. Type: United States: New York to Carolina (Holotype OXF?).

?*Unisema sagitata* Raf., Fl. Ludov. 18. 1817. Type not seen.

Pontederia cordata L. var. *angustifolia* (Pursh) Torrey, Fl. U.S. 1: 343. 1824.

Unisema deltifolia Raf., Med. Fl. 2: 105, 107. 1830. Based on the type of *Pontederia cordata* L.

Unisema purshiana Raf., Med. Fl. 2: 107. 1830. Based on the type of *Pontederia angustifolia* Pursh.

Unisema media Raf., Med. Fl. 2: 107. 1830. Type: United States: "New York to Carolina" (Holotype NY!).

Unisema media Raf. var. *albiflora* Raf., Med. Fl. 2: 107. 1830. Type not seen.

Unisema media Raf. var. *angustifolia* Raf., Med. Fl. 2: 107. 1830. Type not seen.

Unisema obliquata Raf., Med. Fl. 2: 107. 1830. Type: United States: "New Jersey and Virginia". Type not seen.

Unisema latifolia Raf., Med. Fl. 2: 107. 1830. Type: United States: "Southern States". Type not seen.

Unisema latifolia Raf. var. *elatior* Raf., Med. Fl. 2: 107. 1830. Type not seen.

Unisema latifolia Raf. var. *undulata* Raf., Med. Fl. 2: 107. 1830. Type not seen.

Unisema latifolia Raf. var. *albiflora* Raf., Med. Fl. 2: 107. 1830. Type not seen.

Unisema latifolia Raf. var. *pallida* Raf., Med. Fl. 2: 107. 1830. Type not seen.

Unisema acutifolia Raf., Med. Fl. 2: 107. 1830. Type: United States: Carolina. Type not seen.

Unisema heterophylla Raf., Med. Fl. 2: 108. 1830. Type: United States: "New York to Louisiana". Type not seen.

Unisema heterophylla Raf. var. *lanceolata* Raf., Med. Fl. 2: 108. 1830. Type not seen.

Unisema heterophylla Raf. var. *stenocardia* Raf., Med. Fl. 2: 108. 1830. Type not seen.

Unisema rotundifolia Raf., Med. Fl. 2: 108. 1830. Type: United States: "Western States" [Rafinesque (1837); "Kentucky and Illinois"]. Type not seen.

Pontederia cordata L. var. *albiflora* Short, Transylvania J. Med. Assoc. Sci. 32: 3, 7. 1835. Type: United States: Kentucky, marshes around Louisville, *C. W. Short* (Holotype PH!; isotype NY!).

Pontederia caerulea Maund, Bot. Gard. 6: 551. 1836. Type: Great Britain, plant under cultivation, introduced 1830. Type not seen.

Unisema peduncularis Raf., New Fl. 2: 75. 1837. Based on the type of *Pontederia angustifolia* Pursh.

Unisema peduncularis Raf. var. *parvifolia* Raf., New Fl. 2: 75. 1837. Type not seen.

Pontederia nymphaeifolia Kunth, Enum. Pl. 4: 126. 1843. Type: Brazil: *Sello* 235 (Holotype B?, photograph of holotype NY!; isotype PH!).

Pontederia cordata L. var. *typica,* Solms in DC. Monog. Phan. 4: 532, in part. 1883. [that part based on the types of *Pontederia cordata* L., *P. angustifolia* Pursh and *P. cordata* L. forma *brasiliensis* Solms in DC.]

Pontederia cordata L. forma *angustifolia* (Pursh) Solms in DC., Monog. Phan. 4: 532, in part. 1883. [that part based on the type of *Pontederia angustifolia* Pursh]

Pontederia cordata L. forma *brasiliensis* Solms in DC., Monog. Phan. 4: 533. 1883. Type not seen.

Pontederia rotundifolia L. f. var. *nymphaeifolia* (Kunth) Solms in DC. Monog. Phan. 4: 534. 1883.

Pontederia cordata L. [var.] *lancifolia* (Muhl.) Morong. Mem. Torrey Bot. Club 5: 105, in part. 1894. [that part based on types of *Pontederia cordata* L. and *P. angustifolia* Pursh]

Narukila cordata (L.) Nieuwland, Amer. Midl. Naturalist 3: 101. 1913.

Narukila cordata (L.) Nieuwland var. *lancifolia* (Muhl.) Nieuwland, Amer. Midl. Naturalist 3: 101, in part. 1913. [that part based on the types of *Pontederia cordata* L. and *P. angustifolia* Pursh]

Pontederia cordata L. forma *angustifolia* (Pursh) House, New York State Mus. Bull. 243-244: 62. 1923.

Pontederia cordata L. forma *latifolia* (Raf.) House, New York State Mus. Bull. 243-244: 62. 1923.

Pontederia cordata L. forma *albiflora* (Raf.) House, New York State Mus. Bull. 243-244: 62. 1923. Based on the type of *Unisema media* Raf. var. *albiflora* Raf.

Unisema cordata (L.) Farwell, Pap. Michigan Acad. Sci. 3: 91. 1924.

Unisema cordata (L.) Farwell forma *angustifolia* (Pursh) Farwell, Pap. Michigan Acad. Sci. 3: 92. 1924.

Unisema cordata (L.) Farwell forma *latifolia* Farwell, Pap. Michigan Acad. Sci. 3: 92. 1924. Type: United States: New Jersey: Secancus, 15 Sept. 1890, *H. H. Rusby* (Lectotype MICH!); Franklin, Aug. 1873, *H. H. Rusby* (Syntype MICH!).

Pontederia lanceolata Nutt. forma *trullifolia* Fernald, Rhodora 27: 81. 1925. Type: United States: Florida, Okeechobee region, Brevard Co., 3 August 1903, *A. Fredholm* 5927 (Holotype GH!).

Pontederia lanceolata Nutt. forma *brasiliensis* (Solms) Fernald, Rhodora 27: 81. 1925.

Unisema lancifolia (Muhl.) Farwell forma *trullifolia* (Fernald) Farwell, Amer. Midl. Naturalist 11: 73. 1928.

Pontederia cordata L. forma *taenia* Fassett, Rhodora 39: 274. 1937. Type: United States: Maine, Lincoln Co. Damariscotta Lake, Jefferson, shallow mucky cove, 28 August 1936, *N. C. Fassett* 16067 (Holotype WIS!; isotypes GH!, MO!).

Pontederia cordata L. forma *bernardi* Lepage, Naturaliste Canad. 82: 101. 1955. Type: Canada: Quebec, Nominingue, zone tourbeuse autour du lac Violon, 12 aout 1951, *Jean-Paul Bernard* 386 (Holotype CAN!).

Plants up to 11 dm tall (Fig. 9). Leaves cordate (Fig. 8), rarely auricled, or sagittate (unauricled), blades 2.2-21 cm wide; spathe (terminal phyllode of floral shoot) 2-7.4 cm long; petiole of floral shoot leaf (includes sheath base) 4-31 cm long; petiole of other leaves 28.7-59.5 cm long, ligule of petiole sheath up to 10.5 cm long; sheath in axil of floral shoots up to 28 cm long. Inflorescence (Fig. 8) 2-16 cm long; peduncle (inflorescence base to floral shoot leaf base) 5-33 cm long. Perigone blue, purple or white.

In North America restricted to the eastern provinces of Canada (Fig. 10; Ontario, Quebec, New Brunswick, Prince Edward Island and Nova Scotia) and the eastern to midwestern United States (Fig. 11) with greatest concentration along the Atlantic Coastal Plain and the Great Lakes Region as compared with the Mississippi embayment. In Middle America known only from British Honduras (Fig. 12). In South America (Fig. 15) found in Argentina, Brazil, Colombia, Paraguay and Uruguay.

Representative Specimens: CANADA. **Province New Brunswick.** Norton, 20 Aug 1876, *Hay* (CAN). **Province Nova Scotia.** COLCHESTER CO.: Earltown Lake, 29 Jul 1954, *Smith, Webster & Bentley* 11742 (CAN). CAPE BRETON ISLAND: Louisburg, 19 Aug 1898, *Macoun* (CAN). **Province Ontario.** Vermilion River between Lake Superior and Lake Nipissing near Whitefish, 13 Aug 1936, *Grassl* 7494 (MICH). PELEE ISLAND: Essex Co., lagoon N end, 17 Aug 1967, *Stuckey* 5161 (OS). GEORGIAN BAY AREA: Go Home, O.G.U. (CAN). **Province Quebec.** Bell's Lake near Wakefield, 24 Jul 1903, *Macoun* (CAN). UNITED STATES. **Alabama.** BALDWIN CO.: Battleship Parkway, 4 mi E of Mobile, Routes 31-90-38, Mobile Bay Causeway, 15 Jul 1970, *Lowden* 5 (OS). **Arkansas.** CRAIGHEAD CO.: Lake City, *Demaree* 7075 (US).

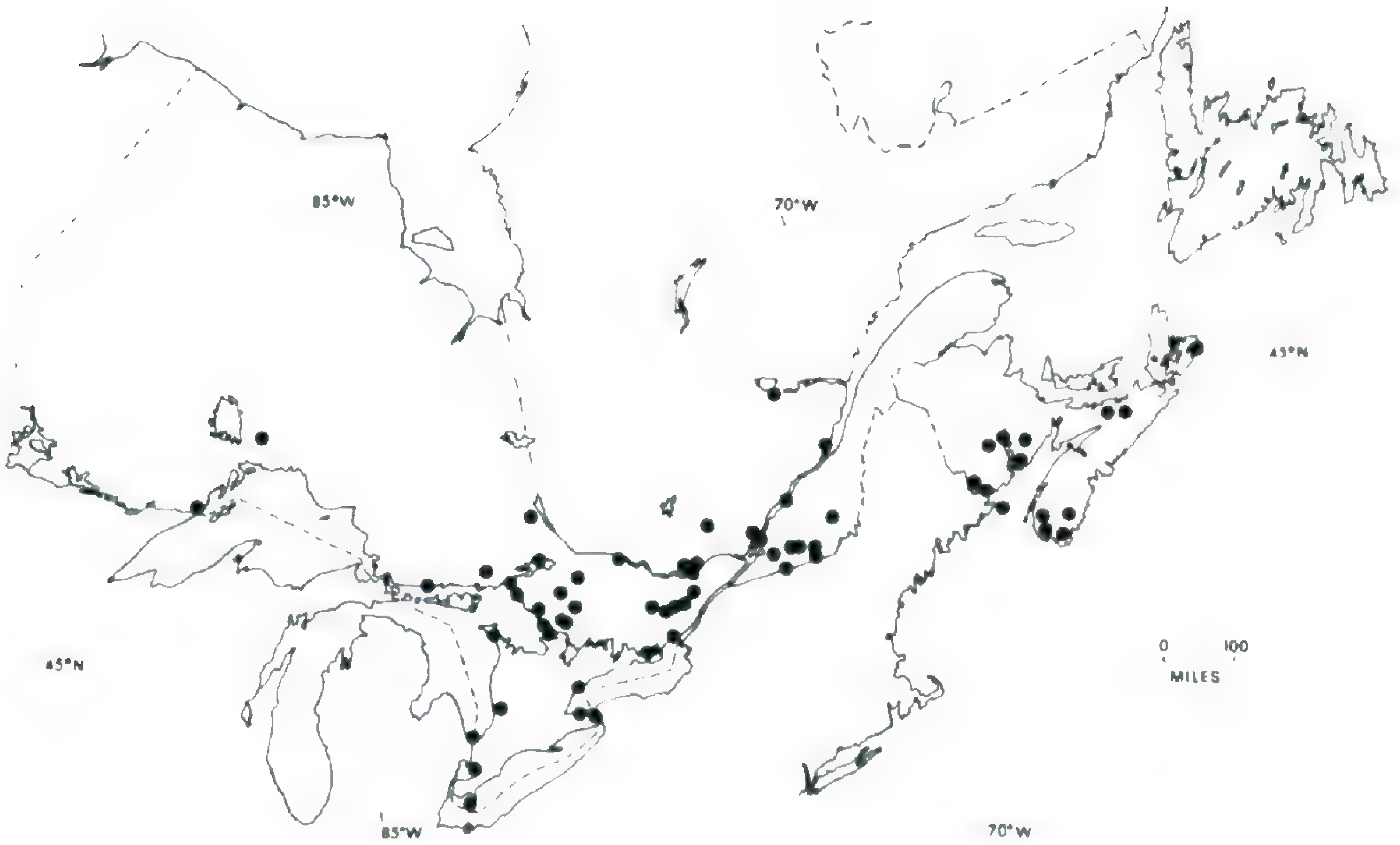


Figure 10. Distribution of *Pontederia cordata* var. *cordata* in Ontario, Quebec, New Brunswick, Prince Edward Island and Nova Scotia Provinces of Canada.

Connecticut. FAIRFIELD CO.: Green Pond, Sherman, 4 Sep 1916, *Pennell* 8592 (PH). **Delaware.** NEW CASTLE CO.: Wilmington, 6 Jul 1843, *Brakely* (PH). **District of Columbia.** Potomac bank, Washington, 28 Jun 1891, *Blanchard* (MO-2). **Florida.** ALACHUA CO.: 2 mi S of Gainesville, 17 May 1940, *Martin* 1457 (DUKE). **Georgia.** LONG CO.: Altamaha River Swamp, 4½ mi SW of Ludowici, 10 Jun 1950, *Duncan* 11089 (GH). **Illinois.** COOK CO.: 131St between Wolf Rd and Will-Cook Rd W of Palos Park Pond, 16 Aug 1941, *Steyermark* 40917 (F). **Indiana.** DEKALB CO.: Diamond Lake, 35 mi N of Auburn, 30 Jul 1933, *Shoop* (F). **Iowa.** BENTON CO.: Vinton, 1879, *Davis* (WIS). **Kentucky.** BALLARD CO.: Wickliffe, Swan Pond, 18 Aug 1923, *McFarland & Anderson* 167 (MO). **Louisiana.** BEAUREGARD PARISH: Near Longville, 29 Apr 1955, *Cooley & Brass* 4072 (GH). **Maine.** LINCOLN CO.: 3 mi S of Newcastle Center off Route 1, 3 Sep 1969, *Lowden* 31 (OS). SAGADAHOC CO.: Cathance River, 1 mi from Topsham, 1½ mi from Bowdoinham, 3 Sep 1969, *Lowden* 29 (OS); Foreside Road near Topsham off Route 24, 3 Sep 1969, *Lowden* 30 (OS). YORK CO.: Bonnie Bay Pond, North Berwick, W of Route 4, 2 Jul 1970, *Lowden* 1 (OS); Kennebunk River, boundary between Kennebunk and Arundel, Route 95, Jul 1970, *Lowden* 4 (OS). **Maryland.** CECIL CO.: Chesapeake City, 7-11 1923, *Tidestrom* 11402 (GH). **Massachusetts.** BARNSTABLE CO.: Hyannisport, 22 Aug 1888, *Churchill* (MO). **Michigan.** BARRY CO.: Long Lake, 14 Aug 1936, *Woodbury* 317 (MICH). **Minne-**

Figure 11. Distribution of *Pontederia cordata* var. *cordata* (dots) and var. *lancifolia* (triangles) in the United States.

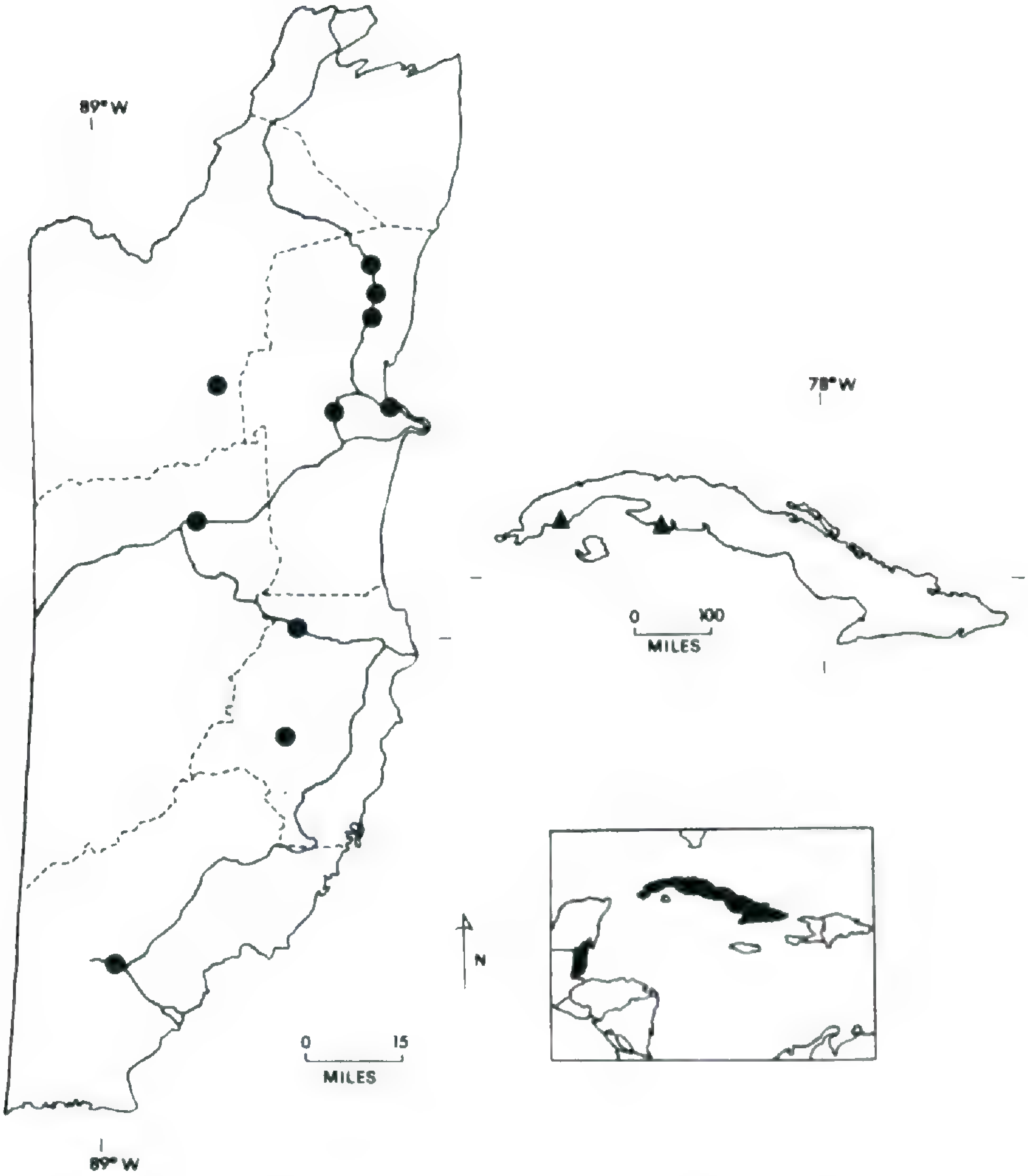


Figure 12. Distribution of *Pontederia cordata* var. *cordata* (dots) in British Honduras (solid lines represent highways), C.A., and var. *lancifolia* (triangles) in Cuba, West Indies.

sota. AITKEN CO.: Rice Lake, Aug 1921, *Kubichek* 143 (MO). **Mississippi.** HANCOCK CO.: Jordan River S of Kiln, 29 Apr 1967, *Jones* 11846 (FSU). **Missouri.** BATES CO.: Prairie Lake, Cygnes River, 1¼ mi SW of Rapinsville, 1 Oct 1938, *Steyermark* 9975 (F, MO). **New Hampshire.** ROCKINGHAM CO.: Exeter River, Philips Exeter Academy, Exeter, 8 Sep 1969, *Lowden* 32 (OS). STRAFFORD CO.: Bellamy River, Exit 7 Spaulding Turnpike, 4 Jul 1970, *Lowden* 2 (OS). **New Jersey.** ATLANTIC CO.: Pleasant Mills, 4 Aug 1907, *Bartram* (PH). **New York.** ESSEX CO.: Lake Harris, Newcomb, 1 Aug 1921, *House* 8431 (CAN). **North Carolina.** BEAUFORT CO.: Cockold Creek, near Bellhaven, 25 Jun 1935, *Correll* 1703 (DUKE). **Ohio.** DEFIANCE CO.: Little Pond off Route 49, 22 Sep 1969, *Lowden* 34 (OS); Big Pond off Route 49, 22 Sep 1969, *Lowden* 35 (OS). LICKING CO.: Cranberry Bog, Buckeye Lake, 12 Oct 1969, *Lowden* 33 (OS). OTTAWA CO.: Winous Pt., 3½ mi SW of Port Clinton off Route 53, 10 Aug 1969, *Lowden* 36 (OS); Winous Pt., 27 Jun 1969, *Lowden* 37 (OS). **Oklahoma.** CHEROKEE CO.: Tahlequah, 21 Jun 1936, *Gruchy* 135 (GH, NY). **Pennsylvania.** BUCKS CO.: Neshaminy Creek, Bridge Point [Edison], 22 Jul 1876, *Meredith* (PH). **Rhode Island.** NEWPORT CO.: Tiverton, Sawdy Pond, 16 Jul 1932, *Sanford* (NEBC). **South Carolina.** ANDERSON CO.: Piedmont, 17 Jul 1919, *Davis* (BKL, MO). **Tennessee.** GRUNDY CO.: Goose Pond, near Pelham, 27 Apr 1936, *Svenson* 7610 (BKL). **Texas.** BEXAR CO.: San Antonio, 3 Oct 1900, *Bush* 1258 (MO). **Vermont.** ESSEX CO.: Bow Pond, Guildhall, 30 Aug 1940, *Pease* 28364 (NEBC). **Virginia.** FAIRFAX CO.: Near Great Falls, 7 Aug 1910, *Dowell* 6435 (GH). **Wisconsin.** ASHLAND CO.: Torrey L., Morse, 16 Jul 1936, *Knowlton* 97 (WIS). CENTRAL AMERICA. **British Honduras.** BELIZE DISTRICT: Northern River, Nov 1933, *Gentle* 944 (GH, MICH, MO, NY); 9 mi N of Belize City, Northern Highway, 24 Dec 1969, *Lowden* 24 (OS); 29 mi N of Belize City, Cowhead Creek, Northern Highway, 30 Dec 1969, *Lowden* 26 (OS); 32 mi N of Belize City, Northern Highway, 30 Dec 1969, *Lowden* 27 (OS); Hattieville-Burrell Boom Road, 5½ mi from Burrell Boom, 30 Dec 1969, *Lowden* 28 (OS). COROZAL DISTRICT: 1931-1932, *Gentle* 388 (F, MICH, US). EL CAYO DISTRICT: 41 mi Sect., Belize-Cayo Road, 1 Apr 1958, *Gentle* 9708 (DUKE, F, MICH, NY, US). ORANGE WALK DISTRICT: Hillbank Lagoon, Feb 1933, *Pelly* 43, 44 (F). STANN CREEK DISTRICT: Cockscomb vic., 18 Jun [1930], *Schipp* S119 (F); 23 mi, Stann Creek Valley, 11 Mar 1932, *Schipp* 955 (F, GH, MICH, MO, NY). TOLEDO DISTRICT: 15 mi, San Antonio-Punta Gorda Road, 28 Nov 1951, *Gentle* 7531 (F, NY, US). SOUTH AMERICA. **Argentina.** PROVINCIA BUENAS AIRES: Depto. Campana, Campana, 27 Nov 1938, *Eyerdam & Beetle* 23070 (GH). PROVINCIA CHACO: Dept. Resistencia, Colonia Benitez, 12 Dec 1928, *Venturi* 7907 (GH, US). PROVINCIA CORRIENTES: Mercedes, 12 leguas al N, XI 1936, *Rodrigo* 750 (NY). PROVINCIA MISIONES: Dept. Apostoles, Tres Galpones, 8 II 1947, *Huidobro* 4817 (MO). TERRITORY FORMOSA: Formosa, 5-1918,

Jorgensen 3005 (MO). **Brazil.** PARANA: Rio Pequeno, auto estude Curitiba-Paranagua, XI 1960, *Brage & Vesreira* 320 (US). PROV. MINAS GERAIS: Brasilia (PH). RIO DE JANEIRO: Brasilia, pr. Lorena, *L. Riedel*, iter Brasiliensis 1821-36 (NY). RIO GRANDE DO SUL: Logoa dos Barros, pr. Osorio, 24 Nov 1949, *Rambo* 44574 (F). SANTA CATARINA: Mun. Chapeco, Fazenda Campo Sao Vicente, 24 km W of Campo Ere, *Smith, Reitz & Sufridini* 9468, 9482 (US). SAO PAULO: Butantan, 17 Oct 1917, *Hoehne* 726 (NY). **Colombia.** COMMISSARIA MAGALENA: Near Valencia, 12 Oct 1944, *Haught* 4406 (F, US). COMMISSARIA VALLE [DEL CAUCA]: Costa del Pacifico, rio Cajambre, Quebrada de Guapecito, 16 May 1944, *Cuatrecasas* 17703 (F). **Paraguay.** Paraguaria Centralis, lacus Ypacaray, Nov 1913, *Hassler* 12683 (GH, MO, NY, US); Dep. Paraguari, Paraguari, Cerro Hu, 25 Nov 1950, *Vervoorst* 564 (MO). **Uruguay.** DEPARTMENT CANELONES: Loc. Dict. Toledo, Nov 1926, *Herter* 522 (F, GH, MO, NY, WIS). DEPARTMENT MALDONADO: Lau [San] Carlos, M 1 1941 *Descole* 104 (GH).

Since none of the original material was located the specimen of Kalm in the Linnaean Herbarium by 1751 was selected as neotype. The numerous names of Rafinesque are placed in synonomy based on their leaf descriptions and geographical locations. A complete list of specimens examined is included in my original dissertation.

The specimens from British Honduras are of particular interest in considering the puzzling disjunct distributions of both *Pontederia cordata* varieties *cordata* and *lancifolia* in North and South America. Actually these specimens are somewhat intermediate between typical *P. cordata* and *P. sagittata*. They have tooth ridged hardened perigone bases like *P. cordata* (Fig. 1A) with the overall perigone shape of *P. sagittata* (Fig. 1B). The leaves have deep sinuses giving the appearance of being slightly auricled. A hybrid origin is suggestive; however, an overlap in geographical ranges between *P. cordata* var. *cordata* and *P. sagittata* is not evident. The specimens in general are more characteristic of *P. cordata* var. *cordata*.

1b. *Pontederia cordata* L. var. *lancifolia* (Muhl.) Torrey, Fl. U.S. **1**: 343. 1824.

Pontederia lancifolia Muhl., Cat. 34. 1813. Type: United States: Car. [Carolina] (Lectotype chosen, PH!), Figure 13.

Figure 13. *Pontederia cordata* var. *lancifolia.* Lectotype of *P. lancifolia* Muhl. in the Muhlenberg Herbarium (PH), showing a narrow lanceolate flowering stalk leaf; at left.

Figure 14. *Pontederia cordata* var. *ovalis.* Holotype of *P. ovalis* Mart. in Roemer & Schultes, showing ovate leaves and hairy peduncles; at right.

Pontederia lanceolata Nuttall, Gen. 1: 216. 1818. Type: United States: Savannah, Georgia [*W. Baldwyn*] (Holotype PH!).

Unisema lancifolia Raf., Alt. Jour. 178. 1833. Based on the type of *Pontederia lancifolia* Muhl.

Pontederia cordata L. var. *lanceolata* (Nutt.) Grisebach, Cat. Pl. Cub. 252. 1866.

Pontederia cordata L. var. *typica*, Solms in DC. Monog. Phan. 4: 532, in part. 1883. [that part based on the type of *Pontederia lanceolata* Nutt.]

Pontederia cordata L. forma *angustifolia* (Pursh) Solms in DC. Monog. Phan. 4: 533, in part. 1883. [that part based on the type of *Pontederia lanceolata* Nutt.]

Pontederia cordata L. *lancifolia* (Muhl.) Morong. Mem. Torrey Bot. Club 5: 105, in part. 1894. [that part based on the type of *Pontederia lancifolia* Muhl.]

Narukila cordata (L.) Nieuwland var. *lancifolia* (Muhl.) Nieuwland, Amer. Midl. Naturalist 3: 101, in part. 1913. [that part based on the type of *Pontederia lancifolia* Muhl.]

Pontederia heterantherimorpha (K. Schum. ex Schwartz) Schwartz in Engler, Bot. Jahrb. 61 (no. 139): 41. 1927. Type: Brazil: "Im Staate Goyaz, *A. Glaziou* 22228. Type not seen.

Unisema lancifolia (Muhl.) Farwell, Am. Midl. Nat. 11: 73. 1928.

?*Pontederia oblonga* Larranaga, Pub. Inst. Hist. Geog. Uruguay 2: 134. 1930. Type not seen.

Plants up to 13 dm tall. Leaves narrow lanceolate (Fig. 13) to broadly ovate-lanceolate, blades 0.4-8.3 cm wide; spathe (terminal phyllode of floral shoot) 2-6.5 cm long.; petiole of floral shoot leaf (includes sheath base) 4-21 cm long; petiole of other leaves 29-59.5 cm long, ligule of petiole sheath up to 10.5 cm long; sheath in axil of floral shoot up to 28 cm long. Inflorescence 2-15 cm long; peduncle (inflorescence base to floral shoot leaf base) 5-33 cm long. Perigone blue to blue purple.

In the United States (Fig. 11) concentrated along the

Gulf Coastal Plain of the southeast extending along the coasts of the northeastern Atlantic seaboard states. Along the southwestern coast of Cuba (Fig. 12), West Indies. In South America (Fig. 15) known from Argentina, Brazil, Colombia, Paraguay and Uruguay.

Representative Specimens. UNITED STATES. **Alabama.** GENEVA CO.: 8 mi S of Samson, 9 May 1967, *McDaniel* 8916 (FSU). **Connecticut.** NEW LONDON CO.: E Lyme, Dodge's Pond Niautic, 19 Aug 1913, *Harger* 6328 (NEBC). WINDHAM CO.: Thompson, Long Pond, 19 Aug 1918, *Weatherby* 4373 (NEBC). **District of Columbia.** Potomac River, Jun 1896, *Morris* 3046 (BKL). **Florida.** BAY CO.: Panama City, Mine Defense Lab vicinity, 1 May 1959, *Jones* (FSU). BREVARD CO.: Indian River near Rockledge, 10-20 Mar 1916, *Bartram* (PH). BROWARD CO.: 11 mi W of Davie, 31 Jan 1940, *Seibert* 1191 (MO, PH). COLLIER CO.: Pinecrest, S of Tamiami Trail between mi 40 and Ochopee, 15 Apr 1952, *Field & Lazar* (US). COLUMBIA CO.: 6 mi N of Lake City, 20 May 1964, *Godfrey* 63755 (FSU). DADE CO.: Everglades, W. of Miami, 1-9 Nov 1901, *Small & Nash* (NY). DE SOTA CO.: Arcadia, 14 Mar 1926, *Williams* (PH). DUVAL CO.: NE Forida, May, *Curtis* 2988 (BKL, F, GH, MO, NY, US). FRANKLIN CO.: 11 mi S of Sumatra, 24 Jul 1957, *Godfrey* 55715 (FSU, GH). GADSDEN CO.: 1 mi W of Ock[h]lockonee River, U.S. 20, 6 Jun 1956, *Redfearn* 2194 (FSU, GH). HAMILTON CO.: 2 mi E of Jasper, 1 May 1959, *Godfrey* 58508 (FSU). HIGHLANDS CO.: Bear Point, Lake Childs, 10 Mar 1945, *Brass* 14779 (GH). HOLMES CO.: U.S. 90, 0.2 mi E of Florida 81 in Ponce de Leon, 1 May 1968, *Stone* 2589-2591 (DUKE, NY). INDIAN RIVER CO.: St. Johns River, 10 mi W of Vero Beach, 22 Feb 1957; *Lemaire* 149 (FSU). JACKSON CO.: 2 mi E of Grand Ridge, 20 May 1960, *Godfrey* 59539 (FSU). LAKE CO.: 13 mi S of Leesburg, 10 Jun 1961, *Godfrey & Reinert* 61036 (FSU). LAKE or ORANGE CO.: Lake Apopka, 25 Apr 1930, *O'Neill-Blanton* 6442 (GH). LEE CO.: Fla. 80, 3 mi E of Tice, 15 Aug 1963, *Henderson* 63-1590 (FSU). LOWNDES CO.: 5 mi E of Valdosta, 5 May 1963, *Godfrey & Houk* 62760 (FSU). MARTIN CO.: Lake Okeechobee, Pelican Lake to Cypress Creek, 11-25 Nov 1913, *J. & G. Small* 4320 (NY). NASSAU CO.: 10 mi E of Hilliard, 23 May 1964, *Godfrey* 64093 (FSU). OKEECHOBEE CO.: Kissimmee River, N end of Lake Okeechobee, 25 Nov 1913, *J. & G. Small* 4383 (NY). PALM BEACH CO.: Loxahatchee Wild Life Refuge, W of Delray Beach, 29-30 Mar 1952, *Field & Lazar* (F, US). POLK CO.: Mountain Lake, Lake Wales, 21 Mar 1952, *Field & Lazar* (US). PUTNAM CO.: Palatka and Lake Ganoga, 18 Apr 1897 & Aug 1903, *Williamson* (PH). **Georgia.** BRANTLEY CO.: Ga. Rts. 15 & 121, 1 mi S of Hoboken, 18 Aug 1967, *Clewell* 2745 (FSU). BROOKS CO.: 1 mi NW of Morven, 6 Jun 1959, *Adams* 182 (FSU). CARLTON CO.: Near Camp Cornelia in Okefenokee Swamp, *Jarrard* 2226 (DUKE). CHATHAM CO.: Savannah, (*Pontederia*

Figure 15. Distribution of *Pontederia cordata* var. *cordata* (dots), var. *lancifolia* (triangles) and var. *ovalis* (stars) in South America.

lanceolata Nutt.), (PH). CLINCH CO.: Dupont, 4 10 1935, *Louett* (DUKE). DEKALB CO.: Lakes, 24 May 1897, *Eggert* (MO). DOOLY CO.: Vienna, Apr 1845, *Rugel* 24 (MICH). ECHOLS CO.: Ga. Rt. 94, 5 mi NW of Statenville, 17 Aug 1967, *Clewell* 2528 (FSU). GLYNN CO.: 7 mi NW of Brunswich, hwy. 341, 16 Apr 1961, *Wright* 41 (GH). LOWNDES CO.: Valdosta, 4 10 1938, *Baker* 2978 (DUKE). RICHMOND CO.: Tubman Home, Augusta, 13 Jun 1924, *Hildebrand* (DUKE). WARE CO.: Between Waycross and Ruskin, 2 Aug 1902, *Harper* 1469 (F, GH, MO, NY, US). WAYNE CO.: Jesup, 4 Jun 1893, *Kearney* (OS). **Indiana.** LAKE CO.: Miller, 24 Jun 1896, *Umbach* (PH). **Maine.** OXFORD CO.: Roxbury Pond, Byron, 20 Jul 1934, *Reed* 440 (DUKE, PH). **Massachusetts.** MIDDLESEX CO.: Fresh Pond, Cambridge, *Ball* [in part] (MO). WORCESTER CO.: East Templeton, 28 Jul 1886, *Partridge* (BKL). **Michigan.** SCHOOLCRAFT CO.: Indian Lake, 25 Jun 1937, *Beckman* 32 (MICH). **New Hampshire.** CARROLL CO.: Chocorua Lake, Tamworth, 3 Aug 1947, *Steele* (NEBC). **New Jersey.** MORRIS CO.: Green Pond, 1 Aug 1894, *Van Sickle* (BKL). **Rhode Island.** WASHINGTON CO.: Exeter, Ieppican Pond, 22 Sep 1920, *Graves & Woodward* (GH, NEBC). **South Carolina.** COLLECTON CO.: 8 mi SE of Walterboro, 18 Jul 1927, *Wiegand & Manning* (GH). SUMTER CO.: Sumter vic., 25 May 1914, *Stone* 438 (PH). **Tennessee.** COCKE CO.: Newport to Greenville, 5 mi E of Newport, 17 Jun 1939, *Sharp & Jennison* 342 (BKL,MO). COFFEE CO.: S of Manchester, 21 Aug 1938, *Svenson* 8775 [in part] (BKL, GH, PH). **Texas.** CHAMBERS CO.: Anahuac, 16 May 1937, *Cory* 22410 [in part] (GH). HARRIS CO.: Cob Pond, Humble, 9 10 1926, *Tharp* 4314 (US). WEST INDIES. **Cuba.** PROV. PINAR DEL RIO, Coloma vic., 28 Feb-2 Mar 1911, *Britton & Cowell* 9693 (GH, NY, US); Cienaga de Zapata, N de la Bahia de Cochinos (Sta Clara), 14 Aug 1920, *Leon & Loustalot* 9530 (NY); PROV. PINAR DEL RIO, near La Coloma, 1 May 1940, *Leon, Victorin & Alain* (GH); Plantae Cubenses Wrightianae, 1860-1864, *Wright* 3260 (GH, MO, NY, US). SOUTH AMERICA. **Argentina.** PROV. BUENOS AIRES, Buenos Aires, Jan 1852, *Andersson* (US); PROV. CORRIENTES, Dept. Ituzaingo, Salto Apipe, 6 X 1949, *Schwarz* 8130 (MO, US). **Brazil.** PARANA, Desiro Ribas, 29 Nov 1910, *Dusen* 10849 (GH, NY, US); PROV. MINAS GERAIS, Brasilia, cidade de Caldas, 1868, *Henschen* (US); Rio Grande Do Sul, Belem Novo, Costa Rio Guahyba, 31 Jan 1948, *Palacios & Cuezzo* 416 (MO); Rio De Janeiro estado, municipio Cabo Frio, Cabo Frio, Praia do Pontal, 17 Apr 1952, *Smith* 6595 (US). **Colombia.** COMMISSARIA MAGDALENA, Poponte, Magdalena Valley, 2 Nov 1924, *Allen* 786 (F, MO); COMMISSARIA PUTUMAYO, Umbria, Dec 1930, *Klug* 1877 (F, GH, MICH, MO, NY, US). **Paraguay.** Iter ad Paraguariam septentrionalem, superioris fluminis Apa, 1901-1902, *Hassler* 7849 (GH, MICH, MO, NY). **Uruguay.** Nueva Palmina [?] (Dto. Colonia), XII 1943-I 1944. *Scolnik* 32 (NY).

This lanceolate to narrowly linear-lanceolate leaved variety (Fig. 13) has a geographically distinct distribution in the southeastern portion of the United States (Fig. 11). The leaf width is quite variable. The extremely ovate-lanceolate forms, suggestive of hybridization, are predominant throughout the overlapping ranges of this variety and *P. cordata* var. *cordata*.

1c. *Pontederia cordata* L. var. *ovalis* (Mart. in Roemer & Schultes) Solms in DC., Monog. Phan. **4**: 533. 1883.

Pontederia ovalis Mart. in Roemer & Schultes, Syst. Veg. **7**: 1140. 1830. [Martius, Fl. Bras. 3(1): 95. 1847.] Type: Brazil (Holotype M; photograph of holotype US!).

Pontederia lanceolata Nutt. var. *vichadensis* Hermann, Caldasia **5**: 39. 1948. Type: Colombia: Vichada, mucky edge of stream in open forest on llanos bordering the Rio Vichada, alt. 100 m, ca. 18 km NE [E.N.E.] of San José de Ocuné, 21 Jan. 1944, *F. J. Hermann* 11045 (Holotype US!).

Pontederia lanceolata Nutt. forma *ovalis* (Mart. in Roemer & Schultes) Castell., Rio de Janeiro Jardin Botanico **15**: 62. 1958.

Plants up to 9 dm tall. Leaves ovate (Fig. 14), blades 2.2-21 cm wide; spathe (terminal phyllode of floral shoot 2.2-7.4 cm long; petiole of floral shoot leaf (Fig. 14, includes sheath base) 5.3-31 cm long; petiole of other leaves 28.7-30.6 cm long, ligule of petiole sheath up to 4 cm long; sheath in axil of floral shoot up to 22.3 cm long. Inflorescence 2.7-16 cm long; peduncle (inflorescence base to floral shoot leaf base) 12.3-28 cm long, densely pubescent next to inflorescence base. Perigone white or pale blue.

In South America (Fig. 15) known only from Bolivia, Brazil, Colombia, Paraguay and Uruguay.

Representative Specimens. SOUTH AMERICA. **Bolivia.** DEPARTMENT BENI: Reyes, 27 Oct 1921, *Rusby* 1389 (BKL, GH, MICH, NY, PH, US). **Brazil.** Prov. Minas Gerais, Dattos de Cima, Mun. Diamantina, 19 Nov 1937, *Barreto* 9817 (F); Rio Grande Do Sul, Neu. Wurhemburg, 10 11 [19]04, *Bornmuller* 356 (GH); *Burchell* A157 (GH); *Burchell* A163 [in part] (GH); 12 km S of Cristaes, Ceara, 28 Aug

Figure 17. *Pontederia sagittata* with sagittate auricled flowering stalk leaves, Mexico, State of Vera Cruz, *R. M. King* 933 (US); at left.

Figure 18. White inflorescences of *Pontederia parviflora*, with subcordate leaves, Panama, Province of Herrera (*Lowden* photo, Aug 1970); at right.

Miramar, 19 Mar 1955, *Sohns* 1658 (MICH, NY, US). STATE OAXACA: Jamiltepec, Distrito Jamiltepec, Oaxaca, 10 Dec 1921, *Conzatti* 4434 (NY); Chiltepec and vic., District Tuxtepec, Jul 1940-Feb 1941, *Martinez-Calderon* 76494 (GH, US); Near San Gabriel Mixtepec, Mpio. de Juquila, 2 km N San Gabriel, 13 Feb 1965, *McVaugh* 22416 (MICH);Laguna Tonameca, Oaxaca, 8 Nov 1917, *Reko* 3451 (US); Foothills Sierra Madre del Sur, 53 km N of Puerto Escondido, road to Zimatlan km 221, 25 Jul 1965, *K. & E. Roe & Mori* 559 (F, WIS). STATE TABASCO: Popal Grande between Frontera and Villahermosa, Aug 1962, *Barlow* (MICH, WIS); W-SW of Huimanguillo, 23 May 1963, *Barlow* 30/52 (WIS); La Palma, Balancan, 1-6 Jun 1939, *Matuda* 3302 (GH, MICH); Curahueso, Tabasco, 6 Jan 1889, *Revirosa* 334 (NY, PH). STATE VERA CRUZ: Wartenberg, near Tantoyuca, prov. Huasteca 1858, *Ervendberg* 277 (GH, PH); Vera Cruz, 12 Aug 1926, *Fisher* 108 (US); prov. Vera Cruz, *Galeotti* 5562 (F, GH, NY, US); Mun. Puente Nacional, km 394 Jalapa-Vera Cruz highway, between Rinconada and Puente Nacional, 13 Feb 1943, *Gilly, Simpson & Dodds* 90 (MICH); Near city Vera Cruz, 23 Jan 1906, *Greenman* 19 (F,

GH); Vera Cruz, in and around, 8 Dec 1958, *Jones* 22660 (WIS); Trans-Isthmian highway Route 185, 17 km NE of Minatitlan, 1 Aug 1958, *King* 933 (MICH, US); *Vera Cruz, El Coyol, Prolongacion Carretera Aleman, 25 Jul 1970, *Lowden* 6 (OS); Carretera Nacional 180, El Puente Teculapilla, 5 km NW of Lerdo Route 180, 26 Jul 1970, *Lowden* 7 (OS); Laguna Catemaco, S edge off Route 180, 27 Jul 1970, *Lowden* 8a-b (OS); Laguna Catemaco, Arroyo Agrio, 6 km from Catemaco Town between Coyame and San Andres Tuxtla, 27 Jul 1970, *Lowden* 9 (OS); Vera Cruz, A° 1853, *Müller* 2145 (NY); Jalapa, 16 Feb 1910, *Orcutt* 2874 (F, GH, MO, US); Barranca de Panoaya, Mar 1923, *Purpus* 9041 (F, GH, MO, NY, US); Rio Maquina, municipio San Andres Tuxtla, 26 Mar 1964, *Quintero* 699 (MICH); Rio Los Tuxtla, municipio Santiago Tuxtla, 29 Aug 1964, *Quintero* 1409 (MICH); Sontecomapan, municipio Catemaco, 5 Aug 1965, *Rzedowshi* 20368 (MICH); Rio Cosolapa, Le Gartera, Ejido San Agustin, 5 km NE of Campo Experimental de Hule, El Palmar, Zongolica, 27 Feb 1944, *Santos* 2821 (MICH); Vera Cruz, inter urbem et Santa Fe et prope los Cocos, Feb, *Schiede & Deppe* 981 (MO, US); Coatzacoalcos, isthmus Tehuantepec, 8 Jan 1895, *Smith* 1034 (F, GH, MICH, MO, NY, US, WIS); Tuxpam [Tuxpan], Rio Vinasco [Rio Vinazco], 9 I 1903, Ex Museo botanico Berolinensi 3731 (GH, US); Distr. San Andres Tuxtla, Laguna Catemaco, 7 III 1907, Ex Museo botanico Berolinensi 5005 (GH). STATE ?: Winter 1877, *Hogg* (NY); San Luis, 27 Feb 1899, *Langlasse* 928 (GH, US); Inter el Morro & Rancho Nuevo, 1841-43, *Liebmann* 1618 (US). CENTRAL AMERICA. **Costa Rica.** PROVINCE LIMON: Matina, IX 1896, *Pittier* 10301 (US). **Guatemala.** DEPARTMENT ALTA VERAPAZ: Coban, M Dec 1886, *Türckheim* 547 (GH, NY, PH, US); Cubilquitz [Gubilquitz], M Apr 1901, *Tüerckheim* 8025 (US). DEPARTMENT IZABAL: Izabal, Rio Mosinga, 2 Jun 1919, *Blake* 7864 (GH, US); Jocolo, Izabal, Lago Izabal, 25 Dec 1920, *Johnson* 1053 (US); Lago Izabal, Izabal vic., 1 May 1966, *Jones & Facey* 3213 (F, NY); Livingston, 18 Jan 1905, *Kellerman* 5131 (OS, US); Quirigua, 31 Jul 1970, *Lowden* 10 (OS). Puerto Barrios, 1 Aug 1970, *Lowden* 11 (OS); Puerto Barrios vic., 29 Dec 1904, *Maxon & Hay* 3061 (US); Rio Dulce, 15 May 1937, *Muenscher* 12623 (F); Livingston, 27 May 1905, *Pittier* 357 (NY, US); Rio Dulce, M Mart 1889, *Smith* 1652 (GH, US); Quirigua vic., 15-31 May 1922, *Standley* 24029 (GH, NY, US); Puerto Barrios vic., 2-6 Jun 1922, *Standley* 25005 (US); near Quirigua, 26-27 Apr 1939, *Standley* 72425 (F); Near Puerto Barrios, 25 Apr-6 May 1939, *Standley* 73170 (F); Between Bananera and La Presa in Montana del Mico, 28 Mar 1940, *Steyermark* 38050 (F, US); Lago Izabal, opp. San Felipe, between San Felipe and mouth of Rio Juan Vicente, 19 Apr 1940, *Steyermark* 39688 (F). DEPARTMENT SAN MARCOS: Rio Suchiate, W of Ayutla, 18 Mar 1940, *Steyermark* 38034 (F). DEPARTMENT PETEN: El Paso, San Pedro River, 26 Apr 1932, *Lundell* 1564 (MICH, NY). DEPART-

MENT ZACAPA: Gualan, 15 Jan 1905, *Deam* 208 (F, GH, MICH, MO, NY, US). DEPARTMENT ?: Feb 1912, *Cockerell* 10 (US); Eastern portions of Vera Paz and Chiquimula, 1885, *Watson* 28, 33, 386 (GH). **Honduras.** DEPARTMENT ATLANTIDA: Ceiba, 26 Sep 1916, Dyer A92 (US); Tela, La Curva, 10 Aug 1970, *Lowden* 15 (OS); Santiago, 11 mi W of Tela, 10 Aug 1970, *Lowden* 16 (OS); La Ceiba, Platanillo, 6 Nov 1948, *Molina & Becker* 1 (F); Tela, 1923, *Severen* 5 (US); Tela vic., 14 Dec 1927-15 Mar 1928, *Standley* 53607 (F, US); Tela River, (Tela) Puerto Sierra, 18 Jan 1903, *Wilson* 70 (F, NY, US); Near Micos Lagoon, 12 km W of Tela, 21 Jul 1934, *Yuncker* 4684 (F, MICH); Ceiba vic., 6 Jul 1938, *Yuncker, Koepper & Wagner* 8249 (F, GH, MICH, MO, NY, US). DEPARTMENT CORTES: Puerto Cortes, 3 Ave-5 Calle 0, 9 Aug 1970, *Lowden* 13 (OS); 13.5 mi inland from Puerto Cortes along main road, 9 Aug 1970, *Lowden* 14 (OS); San Pedro Sula, Depart. Santa Barbara, M Mart 1889, *Thieme* 5510 (GH, US).

Specimens for which identification is not positive. **Guatemala.** DEPARTMENT ALTA VERAPAZ: Route 5, between Semococh and La Laguna, road to Chajmayic, 10 May 1942, *Steyermark* 46362 (F). DEPARTMENT PETEN: Isabilito, 28 Mar 1932, *Lundell* 1445 (MICH, US); El Paso, San Pedro River, 26 Apr 1932, *Lundell* 1564 (US); Santa Teresa, Subin River, 10 Apr 1933, *Lundell* 2709 (F, MICH); Laguna Peten Itza, frente Playa Blanca, Santa Elena, 3 Jan 1970, *Ortiz* 512 (F).

The smooth ridged hardened perigone bases (Fig. 1B) easily distinguish this species. The collection in Costa Rica (Fig. 16) reflects a more continuous distribution along the Caribbean Coastal Plain. Specimens without positive identification are immature vegetative specimens lacking mature perigones.

3. *Pontederia parviflora* Alex., N. Am. Flora **19:** 59. 1937. Type: Panama: Province of Panama, camino del Boticario, near Chepo, altitude 30 to 50 meters, October 1911, *H. Pittier* 4556 (Holotype NY!; isotype US!). Fruiting specimen cited with holotype, Panama, Province of Cocle, Aguadulce, in savannas, near sea level, 3-6 December 1911, *H. Pittier* 4915 (GH!, NY!, US!).

Pontederia cordata L. var. *parviflora* (Alex.) Schery, Ann. Missouri Bot. Gard. **31:** 156. 1944.

Plants (Fig. 18) up to 7 dm tall. Leaves (Fig. 18) subcordate, blades 1.8-10.5 cm wide; spathe (terminal phyllode

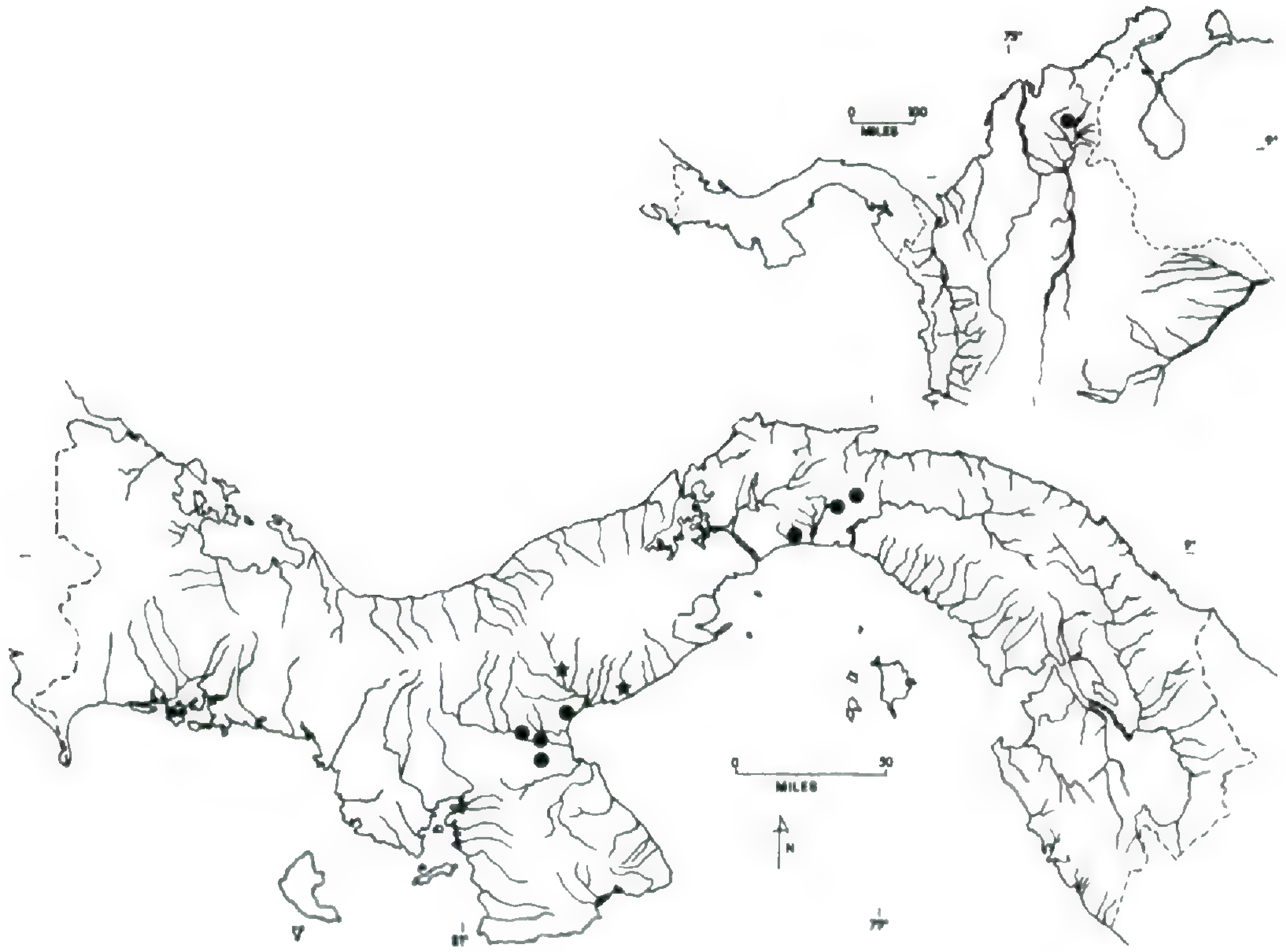


Figure 19. Distribution of *Pontederia parviflora* in Panama and Colombia (stars represent sighted records).

of floral shoot) 5-10.5 cm long; petiole of floral shoot leaf (includes sheath base) 5.5-19 cm long; petioles of other leaves 19-45 cm long; sheath in axil of floral shoot up to 34 cm long. Inflorescence 3-9.5 cm long, peduncle (inflorescence base to floral shoot leaf base) 21-35 cm long. Perigone white to white green; hardened perigone bases (Fig. 1C) toothed ridged; anthers brown to black. Homostylous (Fig. 3D). Fruits and seeds (Fig. 2A-B) reniform.

Known only from the Pacific coast of Panama, Golfo de Panama and the Caribbean Coast of Colombia. Figure 19.

Specimens Examined. CENTRAL AMERICA. **Panama.** PROVINCE COCLE: Aguadulce, 3-6 Dec 1911, *Pittier* 4915 (GH, NY, US); Between Aguadulce and Anton, 12 Jul 1938, *Woodson, Allen & Seibert* 1208 (GH, MICH, MO, NY). PROVINCE HERRERA: Santa Maria, 13 Sep 1938, *Allen* 790 (MICH); Near Divisa, 10 Aug 1962, *Dwyer* 2468 (US); Santa Maria and El Escota, 24 Aug 1970, *Lowden* 20 (OS). PROVINCE PANAMA: Between Panama and Chepo, 29 Nov 1934, *Dodge, Hunter, Steyermark & Allen* 16702 (MICH, MO); Between Pacora and Chepo,

7 mi from Chepo, Tapagara, 26 Aug 1970, *Lowden* 21 (OS); Camino Boticario, near Chepo, Oct 1911, *Pittier* 4556 (NY, US); Swamp E of Rio Tecumen [Rio Tocumen], 11 Dec 1923, *Standley* 26495, 26656 (US); Between Pacora and Chepo, 1 Aug 1938, *Woodson, Allen & Seibert* 1661 (GH, MICH, NY). SOUTH AMERICA. **Colombia.** DEPARTMENT MAGDALENA: Rio de Hacha, near Molino, Sa. Martha, Pur[chi], 1845, Hooker; Costa Del Caribe, oeste de Los Venados, 31 Sep 1961, *Dugand* 5834 (US).

This is the only homostylous member of the genus. Its unique style form (Fig. 3D), white inflorescence (Fig. 18) and brown-black anthers distinguish *Pontederia parviflora* from other members of subgenus *Pontederia.* A wider distribution is expected in South America.

II. *Pontederia* subg. *Reussia* (Endl.) Lowden, comb. nov. *Reussia* Endl. (nom. cons.), Gen. Pl. 139. 1836. Type *Reussia triflora* Seub. in Mart. Fl. Bras. 3 (1): 96. 1847.

Hardened perigone bases (Fig. 1D) spinulose ridged; floral bearing shoots prostrate; aerial stems with long internodes; underground rhizomes short (mature plants).

Subgenus *Reussia* reaches its northern limits in British Honduras and extends into South America as far south as east central Argentina.

4. *Pontederia rotundifolia* L. f., Suppl. 192. 1781. Type: Surinam, *C. G. Da*[h]lberg (Lectotype chosen, [Savage, 407.2], LINN).

Pontederia cordifolia Mart. in Roemer & Schultes, Syst. Veg. 7: 1142. 1830. Type: Brazil: "Crescit in Brasiliae mediterraneae stagnis" (Holotype M; photographs of holotype NY!, US!).

Pontederia brasiliensis Willd. Roemer & Schultes, Syst. Veg. 7: 1145. 1830. Type: Brazil: "In Brasilia prope Para. Com. de Hoffmannsegg". Type not seen.

Unisema orbiculata Raf., Med. Fl. 2: 108. 1830. Type based on the type of *P. rotundifolia* L. f.

Pontederia eriantha Miquel, Linnaea 17: 60. 1843. Type: Surinam: "Crescit Surinami, ad ripas fluminis Commewyne, *Focke*" (Holotype GH!).

?*Pontederia renniformis* Larranaga, Pub. Inst. Hist. Geog. Uruguay 2: 134. 1930. Type not indicated.

Figure 20. Inflorescence of *Pontederia rotundifolia,* showing a bilobed spot on the largest perianth lobe, El Salvador, Laguna de Zapotitan (*Lowden* photo, Mar 1970); at left.

Figure 21. Reniform leaves and short inflorescence of *Pontederia rotundifolia,* Brazil, Territory of Rondonia, *Prance, Forero, Wrigley, Ramos & Farias* 5914 (NY); at right.

Reussia grazielae Machado, Revista Brasil. Biol. 7: 177. 1947. Type: "Amazonas Bahia, in acquis, 1937, *Ducke* 55083 (Holotype RB; photograph of holotype, Machado 1947, Fig. 3).

Reussia rotundifolia (L. f.) Castell., Lilloa 25: 593. 1951.

Plants up to 12 dm tall. Leaves reniform (Fig. 21), sagittate (sometimes deeply auricled) or cordate; blades 3.2-22 cm wide; spathe (terminal phyllode of floral shoot) 2.5-4.5 cm long; petiole of floral shoot leaf (includes sheath base) 4.7-45 cm long; petiole of other leaves 17-54 cm long, ligule of petiole sheath up to 7.5 cm long; sheath in axil of floral shoots up to 24 cm long. Inflorescence (Fig. 20) 2-7.5 cm long, peduncle (inflorescence base to floral shoot leaf base) 6-25 cm long. Perigone pale blue or blue; hardened perigone bases (Fig. 1D) spinulose ridged; anthers

blue. Tristylous (Fig. 3A-C). Fruits and seeds (Fig. 2C-D) ovoid.

In Central America (Fig. 22) a more frequent inhabitant of highland lagoons and lakes than the coastal plains. In South America (Fig. 25) primarily a floristic component of the tributaries of the Amazon Basin.

Specimens Examined. CENTRAL AMERICA. **British Honduras.** TOLEDO DISTRICT: Monkey River, 9 Oct 1941, *Gentle* 3700 (F, GH, MICH, MO, NY, US). **Costa Rica.** PROVINCE ALAJUELA: Lago near Los Chiles, Rio Frio, 1 Aug 1949, *Holm & Iltis* 823 (GH). PROVINCE GUANACASTE: 1 km from Arenal, 2 km from Tronadora, 18 Aug 1970, *Lowden* 19 (OS); Rio Arenal, 5 V 1923, *Valerio* 4 (US); Arenal, 5 IX 1923, *Valerio* 360 (US). PROVINCE LIMON: Barro Colorado de Norte, 8 Mar 1965, *Blaisdell* 267 (FSU); Finca Montecristo, Rio Reventazon below Cairo, 18-19 Feb 1926, *Standley & Valerio* 49024 (US). **El Salvador.** DEPARTMENT LA LIBERTAD: Laguna Zapotitan, 9 Nov 1953, *Fassett* 29320 (MO, WIS); *Laguna Zapotitan, 26 Mar 1970, *Lowden* 23 (OS). DEPARTMENT SAN SALVADOR: San Salvador, 1922, *Calderon* 411 (NY, US); Asino, W end of Lago Ilopango, 30 Oct 1950, *Fassett* 28364 (F, MO, US, WIS); Asino, W end of Lago Ilopango, 8 Jan 1951, *Fassett* 28582 (F, GH, US, WIS); San Salvador vic., 1905, *Renson* 273 (NY, US); Lago Ilopango, W Seite, bei Asino, 7 1 1951, *Rohweder* 566 (F); San Salvador vic., 20 Dec 1921-4 Jan 1922, *Standley* 19143 (GH, NY, US); San Salvador vic., 30 Mar-24 Apr 1922, *Standley* 23284 (GH, US). **Guatemala.** DEPARTMENT ALTA VERAPAZ: Panzos, 19 Nov 1920, *Johnson* 1028 (F, US); Panzos, 1 May 1906, *Lewton* 400 (US). DEPARTMENT IZABAL: Izabal, Rio Izabal, 1 Jun 1919, *Blake* 7844 (GH, US). **Honduras.** DEPARTMENT COMAYAGUA: Pito Solo, Lake Yojoa, 3 Sep 1932, *Edwards* AQ1 (F, GH); *Pito Solo, Lake Yojoa, 8 Aug 1970, *Lowden* 12 (OS); Pito Solo, Lago Yojoa, 18 Apr 1945, *Rodriguez* 2917 (F); Cortez, Lake Yojoa, 7 Jul 1943, *Yuncker* 4840 (F, MICH, MO). DEPARTMENT CORTES: Agua Azul tract No. "B", Lake Yojoa, 16 Aug 1951, *Kamb* 2094 (GH). **Nicaragua.** DEPARTMENT GRANADA: Granada, 11 Feb 1903, *Baker* (GH, MO, NY); Granada, Lake Nicaragua, *J. M. & M. T. Greenman* 5746 (MO); *Granada vic., la Terraza, Lago Nicaragua, 14, 16 Aug 1970, *Lowden* 17 & 18 (OS). DEPARTMENT ?: U.S. North Pacific Exploring Expedition, 1853-56, *Wright* (GH, US). **Panama.** CANAL ZONE: Rio Chagres, near Gamboa, 25 Aug 1939, *Allen* 1963 (GH, MICH, MO); Barro Colorado Island, Jan 1939, *Brown* 30 (F); Ahorca Lagarto to Culebra, 9 Mar 1905, *Cowell* 379 (NY); Frijoles, 17 Jun 1960, *Ebinger* 69 (MO); Barro Colorado Island, near dock, 28 Jun 1960, *Ebinger* 209 (MO, US); Barro Colorado Island, 23 Dec 1963, *Graham* 212 (GH, MICH); Gatun Lake, Jul 1965, *Hayden* 123 (MO); Gatun Station, Panama Railroad,

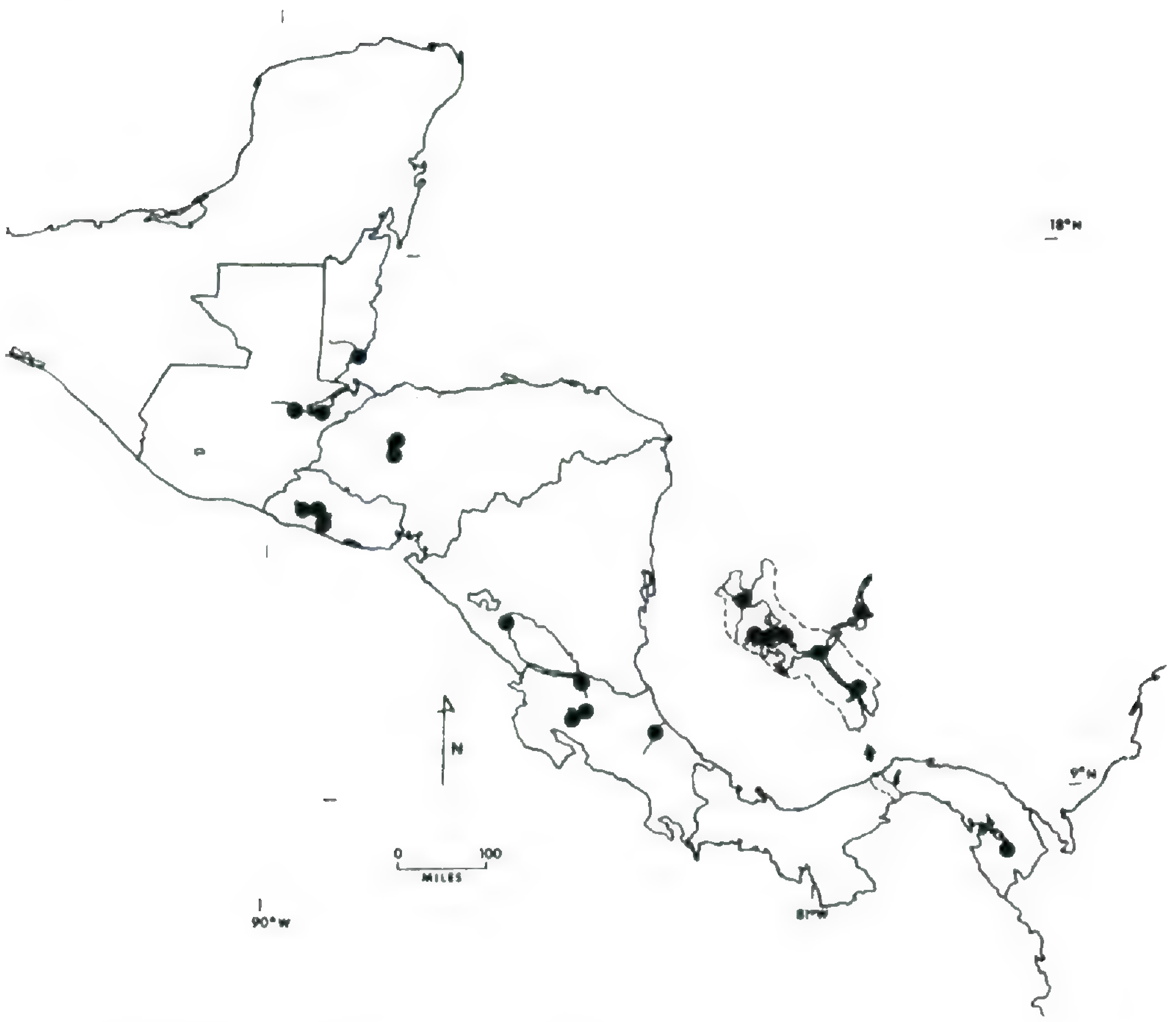


Figure 22. Distribution of *Pontederia rotundifolia* in Central America (arrow points to insert of Canal Zone).

28 Oct 1859, *Hayes* 89, 93 (GH) and 99 (NY); Miraflores Lake, Empire, Culebra Cut and vic., 27 Feb 1935, *Hunter & Allen* 776 (MO); Barro Colorado Island, 24 Jul 1927, *Kenoyer* 602 (US); Chagres River, N of Gamboa, 2 Jun 1969, *Lazor, Correa & Boreham* 3739 (FSU); Chagres River below Gatun, 17 Feb 1911, *Maxon* 4883 (US); Between Gatun and Lion Hill, 26 Jan 1911, *Pittier* 2572 (GH, NY, US); Barro Colorado Island, Barbour Trail, 15 Nov 1931, *Shattuck* 408 (F); Barro Colorado Island, Pena Blanca Bay, 31 Jul 1934, *Shattuck* 1099 (F, MO); Barro Colorado Island, *Starry* 120 (F); Barro Colorado Island boathouse, 25 Jun 1966, *Tyson* 4198 (FSU, MO); Gamboa, 14 Jul 1966, *Tyson, Dwyer & Blum* 4604 (FSU, NY, US); Barro Colorado Island, Chapman Trail, 28 Feb 1931, *Wilson* 74 (F); Madden Lake, 3-20 Aug 1940, *Woodson & Schery* 949 (MO, NY, US); Barro Colorado Island, W of end of T. Barbour Trail, 11 Feb 1932, *Woodworth & Vestal* 479 (F, GH). PROVINCE DARIEN: Rio Pirre, Apr 1966, *Duke & Bristan* 8307 (MO). SOUTH AMERICA. **Argentina.** Entre Ensenada and Punta Lara, Prov. Buenos Aires, La

Plata, 2 Apr 1931, *Cabrera* 1708 (NY); Buenos Aires, Rio Santiago, Prov. Corrientes, 18 Apr 1964, *Cabrera* 15915 (NY); Camino de Santa Fe, Laguna Stubal's Guadalupe, Prov. Santa Fe, 1 II 1936, *Job* 679 (NY); Estancia "Santa Teresa", Dep. Mburucuya, Prov. Corrientes, 2 4 1954, *Petersen* 2657 (MO, US); Prope Barra, Prov. Rio Negro, May 1851, *Spruce* 1486 (NY). **Bolivia.** DEPARTMENT BENI: Lake Rogagua, 3 Nov 1921, *Cardenas* 1417 (BKL, MICH, NY, US); Rio Chapare-Mamore, VIII 1926, *Werdermann* 2198 (MO); Reyes, 25 Oct 1921, *White* 1513 (BKL, NY). DEPARTMENT LA PAZ: Ixiamas, 21 Dec 1921, *Cardenas* 2031 (BKL, MICH, NY). DEPARTMENT SANTA CRUZ: Yapacani, VI 1892, *Kuntze* (NY); Prov. Para, 6 Feb 1925, *Steinbach* 6977 (GH). **Brazil.** STATE AMAZONAS: Basin Rio Madeira, municipality Humayta, between Monte Christo and Santa Victoria, Rio Ipixuna, 15-17 Nov 1934, *Krukoff* 7129 (F, GH, MICH, MO, NY, US). STATE PARA: Belem, Mar-May 1929, *Dahlgren & Sella* 525 (F, US), 557 (F, GH); Villa Carmo, municipio Cameta, 4 Jul 1935, *Drouet* 1999 (GH, MICH, US); Taperinha bei Santarem, Amazonas armes Ayaya, II VI 1927, *Ginzberger & Zerny* 757 (F); Rio Parana, Barra do Rio Piquiry, State of Parana, Mun. Guaira, 9 IV 1961, *Hatschbach* 8078 (US); Bocca do Paru, Region Lower Amazon, 28-29 Aug 1934, *Krukoff* 5935 (GH, NY); Amazonia, 28 Sep 1945, *Pires & Black* 770 (GH); Amazonia, Territory Rondonia, Basin Rio Madeira east bank at Abuna, 12 Jul 1968, *Prance, Forero, Wrigley, Ramos & Farias* 5914 (NY, US); Amazonia, Territory Rondonia, Basin Rio Madeira, Rio Pacaas Novos, 3 Aug 1968, *Prance, Forero, Wrigley, Ramos & Farais* 6764 (NY, US). **Colombia.** Frontera Colombo-Ecuatoriana, commissaria Putumayo, rio San Miguel entre los afluentes Bermeja y Conejo, 13 Dec. 1940, *Cuatrecasas* 11054 (F, US); Mocoa, camino de herradura antiquo y rio Rumiyaco, 10 Oct 1965, *Garcia-Barriga, Hashimoto & Ishikawa* 18685 (NY); Amazonas, Trapecio Amazonico, Loretoyacu River, Nov. 1945, *Schultes* 6935 (US); Amazonas, Trapecio Amazonico, Amazon River, Leticia, Sep 1946, *Schultes* 8188 (US). **Guiana.** Martin, Ex Herbario Musei Britannici (F). **Paraguay.** Lag. Ypacaray, 1885-1895, *Hassler* 1196 (NY); Lacus Ypacarai, Dec 1900, *Hassler* 3693 (NY); Lacus Ypacarai regione, 1913, *Hassler* 11861 (F, GH, MO, NY, US); San Bernardino, Dept. Cordillera, 4 II 1951, *Sparro & Vervoorst* 2316 (GH); Apr-May 1845, *Weddell* 3156 (NY). **Peru.** DEPARTMENT LORETO: Requena, Prov. Requena, Ucayalio Fangoso, 22 Aug 1965, *Sagastequi & Aldave* 5757 (US); Pebas, Amazon River, 29 Jul 1929, *Williams* 1854 (F); La Victoria, Amazon River, 5 Sep 1929, *Williams* 3097 (F, US). **Surinam.** *Focke* (GH); Via secta ab Wia-bank and Grote Zwiebelzwamp, 23 Nov 1948, *Lanjouw & Lindeman* 1236 (NY). **Venezuela.** Pto. de La Ceiba, sur lago de Maracaibo, Edo. Trujillo, Jan 1961, *Aristeguiseta* 4443 (US); C. Araguo [Boca Araguao], State Delta Amacuro, Dec 1952, *Gines* 4881 (US); 12 km SW of

Punta de Piedra towards Sacramento, Estado Tachira, 27-30 Aug 1966, *Steyermark & Rabe* 96610 (US).

This vigorous species is quite variable in size and leaf forms. In particular, specimens with sagittate leaves have been confused with *Pontederia sagittata.* The spinulose hardened perigone bases (Fig. 1D) and fewer flowered globose inflorescences (Fig. 20) readily distinguish *P. rotundifolia* from members of subgenus *Pontederia.*

5. *Pontederia subovata* (Seub. in Mart.) Lowden, comb. nov.

Eichhornia subovata Seub. in Mart. Fl. Bras. 3 (1): 91. 1847. Type: Brazil: Prov. Goyazana, 1836-1841, *Gardner* 4022 (Lectotype chosen, NY!); prov. Bahiensi, *Blanchet* 2720.

Reussia triflora Endl. ex Seubert in Martius, Fl. Bras. 3 (1): 96. 1847. Type: Brazil: *Pohl, Sellow.* Type not seen.

Pontederia schomburgkiana Klotzsch in Schomburgk., Vers. Faun. & Fl. v. Brit. Guiana 1118. 1848. Type: British Guiana: "Im See Venturu und auf stromlosen Stellen des Pirara in der Nähe seiner Quelle". Type not seen.

Pontederia lagoënsis Warming in Videnskab. Meddel, p. 323, T. VI. 1871. Type: Brazil: Min. Geraes, Lagoa Santa. Type not seen.

Reussia subovata (Seub. in Mart.) Solms in DC., Monog. Phan. **4**: 534. 1883.

Reussia lagoënsis (Warm.) Castell., Arq. Jard. Bot. Rio de Janeiro **16**: 209. 1958.

Plants up to 30 cm tall. Leaves subovate (Fig. 23), ovate lanceolate or elliptic (Fig. 24); blades 0.2-4.4 cm wide; spathe (terminal phyllode of the floral shoot) 1.9-5 cm long; petiole of floral shoot leaf (includes sheath base) 4-10 cm long; petiole of other leaves 6.5-25 cm long, ligule (Fig. 23) of petiole sheath up to 3.5 cm long; sheath in axil of floral shoot up to 6.5 cm long. Inflorescence (Fig. 23) 3-8 cm long; peduncle (inflorescence base to floral shoot leaf base) 5-14 cm long. Perigone ephemeral, blue purple,

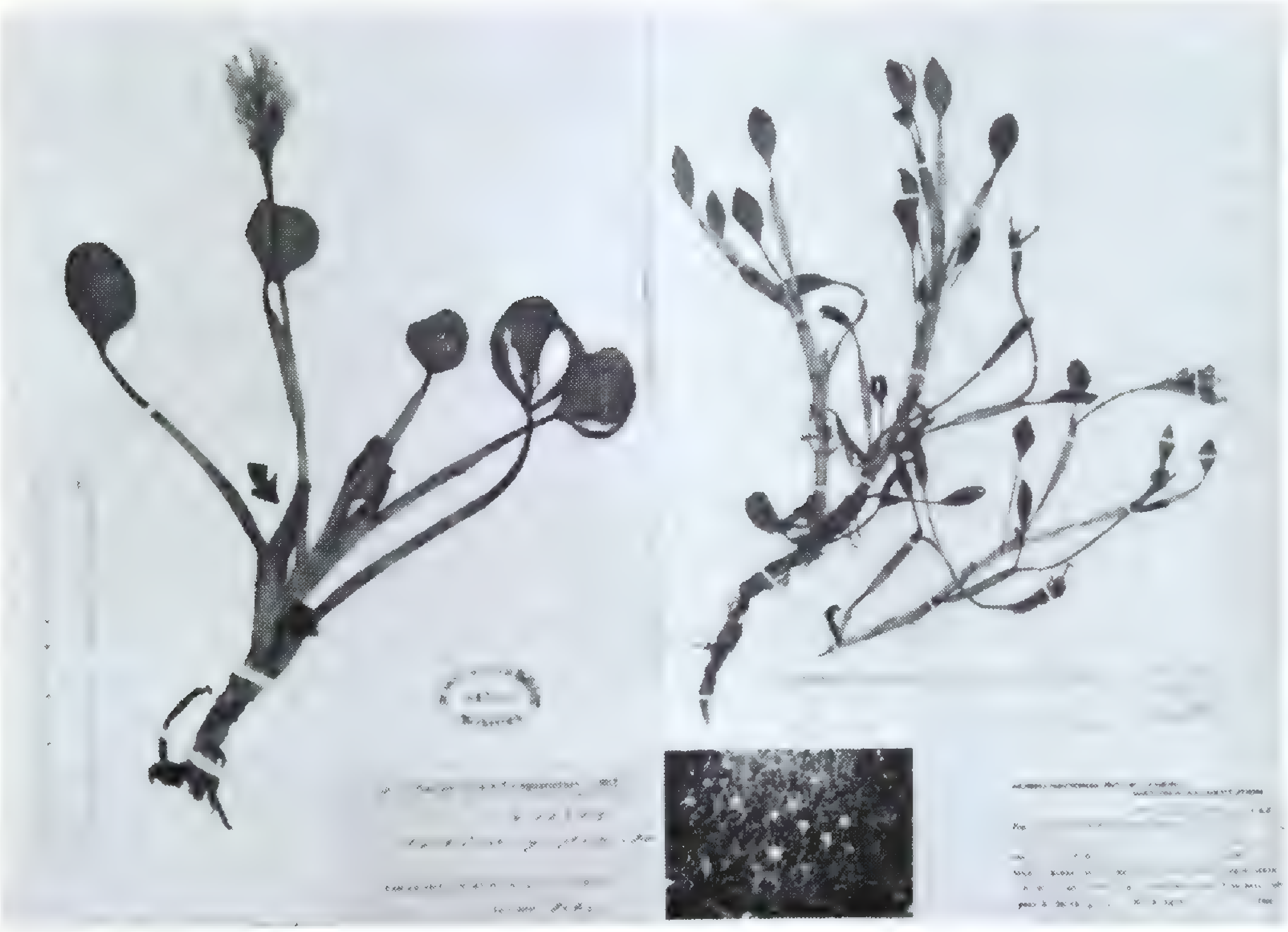


Figure 23. Inflorescence and subovate leaves of *Pontederia subovata* (arrow points to a ligule of a petiole sheath), Paraguay, Ypacaray, *E. Hassler* 12503 (MO); at left.

Figure 24. Narrow subovate-lanceolate leaf variant of *Pontederia subovata*, Brazil, Minas Gerais, Lagoa Santa, *L. B. Smith* 6702 (US); at right.

blue green or pale blue; hardened perigone bases spinulose ridged; anthers blue. Tristylous.

Inhabits swamps and lakes of Argentina, Bolivia, Brazil, British Guiana, Paraguay and Venezuela. Figure 25.

Specimens Examined. SOUTH AMERICA. **Argentina.** Territorio de Formosa, 4 1919, *Jorgensen* 3347 (GH, US); Prov. Chaco, Loc. Colonia Benitez, 10 II 1941, *Meyer* 3864 (F, GH, NY); Estancia, "Santa Teresa", Dep. Mburucuya, Prov. Corrientes, 4 1 1952, *Petersen* 1427 (NY, US). **Bolivia.** Trinidad [Dept. of Beni], 7 Mar 1922, *Cardenas* 27 (GH, NY); Santa Cruz, Chiquitos, between El Carmen & Palmito-Chiquitos, II 1950, *Cardenas* 4488 (US); Reis, Jun 1886, *Rusby* 553 (GH, NY). **Brazil.** 1836-1841, *Gardner* 4022 (NY); Loc. S. Tereziuha, Mun. Ituiutaba, Estado Mg [Minas Gerais], 23 Apr 1950, *Macedo* 2326 (NY); Loc. S. Terezuiha, Estado Minas, Mun. Ituiutaba, 18 Feb 1951, *Marcedo* 3168 (US); Canoas, Estado do Rio Grande do Sul, 1 2 1949, *Miguel* 23 (F, GH, US); Minas Gerais, Mun. Lagoa Santa, Lagoa Santa, 3 May 1952, *Smith* 6702 (F, GH, NY, US).

Figure 25. Distribution of *Pontederia rotundifolia* (dots) and *P. subovata* (triangles) in South America.

British Guiana. Rupununi, 20 mls. S. of Lethem, road to Wichabi, 22 Nov 1957, *Cooke* 197 (NY); Twinpools South Sand Creek, *Cooke* 205 (NY); Rupununi Northern Savanna, Mauritia Swamp, ¼ mi N Waruma, 30 Sep 1963, *Goodland* 897 (US). **Paraguay.** Iter ad Paraguariam Septentrionalem, prope Concepcion, Sep 1901/2, *Hassler* 7352 (GH, NY); Paraguaria Centralis, in regione lacus Ypacaray, Feb 1913, *Hassler* 12503 (GH, MO, NY, US); Pilcomayo River, 1888-1890, *Morong* 859 (NY). **Venezuela.** State Cojedes, near San Carlos, 15 Jan 1939, *Alston* 6311 (WIS); Apure, near Cunaviche, 13 Feb 1941, *Chardon* 254 (US).

The subovate and lanceolate leaf forms are quite variable, however, distinct. The narrow almost linear-lanceolate variants (Fig. 24) are not formally treated since material studied was limited. The hardened perigone bases are spinulose ridged.

ACKNOWLEDGEMENTS

This study (Paper no. 799, Botany Department, The Ohio State University) is a revised version of the original presented as partial fulfillment of the requirements for the Doctor of Philosophy Degree at The Ohio State University. Dr. Ronald L. Stuckey was the dissertation advisor. The Organization for Tropical Studies, Inc. (OTS Pilot Research Grant F 70-23) funded field research in Mexico and Central America during the summer of 1970. The Graduate Committee of the Department of Botany and the Graduate School Fellowship Committee (The Ohio State University) awarded a University Dissertation Year Fellowship for the completion of this investigation. Directors of the following herbaria are gratefully acknowledged for the loan of specimens studied: Arnold Arboretum (A), Brooklyn Botanic Garden (BKL), National Museum of Canada (CAN), Duke University (DUKE), Field Museum of Natural History (F), Florida State University (FSU), Gray Herbarium (GH), University of Michigan (MICH), Missouri Botanical Garden (MO), New England Botanical Club (NEBC), New York Botanical Garden (NY), Ohio State University (OS) and Franz Theodore Stone Laboratory (FTSL), Academy of Natural Sciences of Philadelphia

(PH), Smithsonian Institution (US), and University of Wisconsin (WIS).

LITERATURE CITED

ADANSON, M. 1763. Familles Des Plantes, pp. 54 & 581. Vincent.

ALSTON, R. E. 1967. Biochemical Systematics. *In* Dobzhansky, Hecht and Steere (eds.), Evolutionary Biology, **1**, pp. 197-305. New York.

BAKER, H. G. 1970. Evolution in the Tropics. Biotropica **2**: 101-111.

BOWDEN, W. M. 1945. A list of chromosome numbers in higher plants. II. Menispermaceae to Verbenaceae. Am. J. Bot. **32**: 191-201.

BRITTON, N. L. and H. A. BROWN. 1913. An Illustrated Flora of the Northern United States, Canada and the British Possessions, 2nd ed., **1**, pp. 462-463. New York.

CASTELLANOS, A. 1951. Revision de las Pontederiaceae Argentinas. Lilloa, Revista de Botanica **25**: 585-594.

————————. 1958. Las Pontederiaceae de Brazil. Rio de Janeiro Jardin Botanico **16**: 149-216, tab. 1-18.

CORE, E. L. 1966. Vegetation of West Virginia, p. 140. Parsons.

ENDLICHER, S. L. 1836. Genera plantarum, **1**, pp. 137-139. Vienna.

FARWELL, O. A. 1924. Notes on the Michigan Flora. Part VI. Pap. Michigan Acad. Sci. **3**: 87-109.

————————. 1928. Contributions to the Botany of Michigan No. 15. Miscellaneous Notes. Am. Midl. Natl. **11**: 72-85.

FERNALD, M. L. 1925. *Pontederia* versus *Unisema*. Rhodora **27**: 76-81.

HITCHCOCK, A. S. and M. L. GREEN. 1929. International Botanical Congress, Cambridge (England), 1930, Nomenclature, Proposals by British Botanists, pp. 110-114, 144. London.

KNOWLTON, F. H. 1922. Revision of the Flora of the Green River Formation, with descriptions of new species. U.S. Geol. Surv., Profess. Paper no. 131: 133-182, pl. 36, fig. 6.

LINNAEUS, C. 1737a. Genera plantarum, 1st ed., p. 102. Leiden.

————————. 1737b. Hortus cliffortianus, p. 133. Amsterdam.

————————. 1753. Species plantarum, **1**, p. 288. Stockholm.

————————. 1754. Genera plantarum, 5th ed., p. 140. Stockholm.

MABRY, T. J., K. R. MARKHAM and M. B. THOMAS. 1970. The Systematic Identification of Flavonoids, 354 pp. New York.

NUTTALL, T. 1818. The Genera of North American Plants and a Catalogue of the Species, to the Year 1817, **1**, pp. 215-217. Philadelphia.

ORNDUFF, R. 1966. The Breeding System of *Pontederia cordata* L. Bull. Torr. Bot. Club **93**: 407-416.

PURSH, F. 1814 [1813]. Flora Americae Septentrionalis; or, a Systematic Arrangement and Description of the Plants of North America, **1**, pp. 223-224. London.

RAFINESQUE, C. S. 1808. Prospectus of Mr. Rafinesque Schmaltz's two intended works on North-American Botany. Medical Repository, second hexade, **5**, no. 4, pp. 350-356. New York.

———. 1830. Medical Flora; or Manual of the Medical Botany of the United States of North America, **2**, pp. 105-108. Philadelphia.

———. 1837. New Flora of North America. Part II Neophyton, 96 pp. Philadelphia.

SCHUCHERT, C. 1935. Historical Geology of the Antillean-Caribbean Region, 811 pp. New York.

SCHULZ, A. G. 1942. Las Pontederiaceas de la Argentina. Darwiniana **6**: 45-82, 5 pl.

SCHWARTZ, O. 1927. Zur Systematik und Geographie der Pontederiaceen. *In* Engler, Bot. Jahrb. **61**, Beibl. no. 139, pp. 28-50.

———. 1930. Pontederiaceae. *In* Engler and Prantl, Die Naturlichen Pflanzenfamilien, ed. 2, **15a**, pp. 181-188.

SCULTHORPE, C. D. 1967. The Biology of Aquatic Vascular Plants, 610 pp. London.

SMITH, W. R. 1898. A Contribution to the Life History of the Pontederiaceae. Bot. Gaz. **25**: 324-337, pl. 19-20.

SOLMS-LAUBACH, H. 1883. Pontederiaceae. *In* A. DeCandolle, Monographiae Phanerogamarum, 4, pp. 501-535.

SPRAGUE, T. A. 1924. Unwarranted Changes in Generic Names. J. Bot. **62**: 327-328.

TORREY, J. 1824. A Flora of the Northern and Middle Sections of the United States, **1**, pp. 342-343. New York.

FACULTAD DE CIENCIAS Y HUMANIDADES
DEPARTAMENTO DE CIENCIAS NATURALES
UNIVERSIDAD CATOLICA MADRE Y MAESTRA
SANTIAGO DE LOS CABALLEROS
REPUBLICA DOMINICANA, ANTILLAS (W.I.)

Table 2. Chromosome Counts of *Pontederia* Taxa Investigated

Taxon	Haploid Counts	Vouchers (OS)
subg. *Pontederia*		
P. cordata var. *cordata*	8	U.S.: Ohio, Ottawa Co., Winous Pt., SW of Port Clinton, *Lowden* 36, 37; New Hampshire, Strafford Co., Bellamy River, *Lowden* 2. British Honduras: Belize District, 9 miles N of Belize City, Northern Highway, *Lowden* 24.
P. sagittata	8	Mexico: State Vera Cruz, Vera Cruz, *Lowden* 6, Lerdo, *Lowden* 7 and Laguna Catemaco, *Lowden* 9. Guatemala: Dept. Izabal, Quirigua, *Lowden* 10 and Puerto Barrios, *Lowden* 11. Honduras: Dept. Cortes, Puerto Cortes, *Lowden* 13 and 13.5 miles inland from Puerto Cortes *Lowden* 14; Dept. Atlantida, Tela, *Lowden* 15 and Santiago, 11 miles W of Tela, *Lowden* 16.
P. parviflora	8	Panama: Province Herrera, Los Llanos de Santa Maria, *Lowden* 20; Province Panama, between Chepo and Pacora, 7 miles from Chepo, *Lowden* 21.
subg. *Reussia*		
P. rotundifolia	16	Honduras: Dept. Comayagua, Lago Yojoa, Pito Solo, *Lowden* 12. Nicaragua: Dept. Granada, near Granada, *Lowden* 17, 18. Costa Rica: Province Guanacaste, 1 km. from Arenal, 2 km. from Trenadora, *Lowden* 19. El Salvador: Dept. La Liberatad, Laguna Zapotitan, *Lowden* 23.

Table 3. Spot Colors of Phenolic Compounds in *Pontederia* and Related Genera

Spot #	*No Reagent* Visible Light	*No Reagent* UV Light	*Reagent* NH4OH UV Light
1		aqua	green (in part)
2		aqua	green (in part)
3		purple	yellow green brown (in part)
4		cream-yellow	
5		blue purple	
6		green blue-cream purple	
7		white blue	
8		aqua	
9		dark blue	
10		aqua	green (sometimes)
11a		rose cream	
11b		blue green-pale blue	
11c		blue purple	
12	green brown	green yellow, red brown-pink purple	
13	green brown	pink purple-bright pink	
14		purple, blue-white blue	
15a		yellow green brown	
15b		yellow	
16	pink (sometimes)	bright-dull pink	
17		purple	
18		dull green blue-purple	
19		dull pink	
20		dull yellow green brown-green blue	
21		salmon	
22		yellow green brown	
23		yellow-gray cream	
24		pale blue	
25		dark yellow green brown	
26		dull pink purple	

Table 4. Summary of Spot Occurrence of Phenolic Compounds in *Pontederia* and Related Genera[2]

Taxon	Spot # 1	2	3	4	5	6	7	8	9	10	11a	11b	11c	12	13
Pontederia cordata var. *cordata*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pontederia cordata var. *lancifolia*	+	+	+	+	+	+	+	+	+	+	+			+	+
Pontederia cordata var. *ovalis*	+	+	+	+	+		+	+	+			+		+	+
Pontederia sagittata	+	+	+	+		+	+	+	+	+	+	+	+	+	+
Pontederia parviflora	+	+	+	+	+	+	+	+	+	+	+		+	+	+
Pontederia rotundifolia	+	+	+	+	+	+	+	+	+	+	+			+	+
Heteranthera limosa	+			+		+	+	+	+	+				+	+
Eichornia crassipes	+	+	+	+			+	+	+	+	+			+	+

[2]A + sign represents the presence of phenolic compounds based on position and color of spot on chromatograms. *Eichhornia* and *Heteranthera* vouchers are: *E. crassipes*, Mexico, State Vera Cruz, Carretera Nacional 180, El Puente de Teculapilla, 5 km NW of Lerdo, *Lowden* 41 (os); *E. crassipes*, El Salvador, Lago Illopango, W side of Apulo, *Lowden* 39 (os) & Honduras, Lago Yojoa, Pito Solo, *Lowden* 40 (os); *H. limosa*, Panama, Province Herrera, Los Llanos de Santa Maria, *Lowden* 38 (os).

Table 4. (cont.)

Taxon	14	15a	15b	16	17	18	19	20	21	22	23	24	25	26	Sample Size
Pontederia cordata var. *cordata*	+	+	+	+	+	+	+	+	+		+	+	+		77
Pontederia cordata var. *lancifolia*		+		+							+		+		4
Pontederia cordata var. *ovalis*	+				+			+							1
Pontederia sagittata	+	+		+		+	+	+		+	+	+	+	+	100
Pontederia parviflora	+			+				+				+	+		37
Pontederia rotundifolia	+			+	+		+	+				+	+	+	86
Heteranthera limosa				+		+							+		3
Eichornia crassipes				+			+	+	+						3

AN UNUSUAL SUBSTRATE FOR POLYSIPHONIA PANICULATA MONTAGNE. Once in a while the curious juxtaposition of circumstances leads to an unusual find. Such a situation occurred during the summer of 1972 when we were exploring the algal communities along the edge of the San Andreas fault, at one of its drowned points. The fault emerges from a land position to follow Tomales Bay some 60 miles northwest of San Francisco. From Tomales Bay the fault lies under Bodega Bay and across Bodega Head, still on a northwesterly line.

We were engaged in field work for the Pacific Marine Station at Dillon Beach, California, and while working the mud flats along the east side of Tomales Bay at a place known as Lawson's Landing came across a rather curious partnership. Here we found a presumably symbiotic partnership between the rhodophycean alga *Polysiphonia paniculata* Montagne and the Horseneck Clam, *Tresus nuttalli* Conrad.

At the time we were collecting macroalgae, various species of *Ulva* being very common on the flats, and as we examined a stand of *Zostera marina* L. in a shallow subtidal area, we found individual plants of *Polysiphonia paniculata* scattered throughout the *Zostera.* Upon grasping the alga it became readily apparent that something unusual was occurring, because the alga would quite noticeably retract into the mud. Small plants would actually vanish from sight, going to depths that made any attempt to collect them futile. The first samples we collected of the alga lacked the lower portions.

Further search among the Zostera revealed another movement; whenever several hunters gathered around one of the *Polysiphonia* plants, it would "settle" downward several centimeters, almost as if it were anticipating our next action. Never having had algae attempt to "get away" before, we concentrated on solving the mystery. After several more misses, we succeeded in getting a whole plant, the trick being for one person to stalk the plant, and moving carefully, to use a long bladed knife to cut through

the mud as deeply as possible below the protruding portion of the plant as the grab for the plant was made.

The cut brought to light a portion of the substrate to which the *Polysiphonia* was attached, and it proved to be the distal portion of the siphon of *Tresus nuttalli.* That the alga was firmly attached to the siphon was quite apparent, and subsequent microscopic examination revealed that the prostrate branches of the *Polysiphonia* had penetrated into the epidermal tissue of the siphon to a depth of several millimeters. Most of the samples we obtained in this manner were evidently from older clams, being 2 plus centimeters in the longest dimension.

Our examination of the general area suggested that the *Polysiphonia* serves to hide the siphon from overhead observation, thus affording some degree of protection to the clam. At no time were we able to see a protruding siphon or any evidence that a siphon was present, although the alga was very evident. We collected during low tide periods, and this did not coincide with the clam's feeding times. As far as we were able to determine over the several acres of flats, the association was confined to the stands of *Zostera.* On the open areas of the flats, heavily dug over by clam diggers, only siphons or siphon holes were to be seen.

We were unable to determine the significance of the association other than on an inferential basis. Generally in this region *Polysiphonia* can be regularly found wherever a firm substrate and tidal flow can be paired. It seemed logical to us that the clam benefited from the position of the alga, and that the alga would in turn benefit from the flow of water into and out of the siphon of the clam. This flow certainly would provide a source of nutrients better than the usual rock or wharf substrate.

A search among specimens in the herbarium at the Station revealed that previous collections of *Polysiphonia* had been made in the same mud flat area, but there was no reference to the type of substrate from which these previous collections were made. Due to the lack of any

other suitable substrate on the flats, we infer that the association we found is not new to this area. *Polysiphonia paniculata* was also collected at the north end of Dillon Beach, but in each instance the substrate was a rock surface slightly buried in sand.

Although *Tresus* is reported to serve as a host for a variety of smaller fauna (Ricketts et al., 1968), we are unaware of any previous reports of an alga living in such a partnership with this clam.

REFERENCES

RICKETTS, E. F., J. CALVIN, and J. W. HEDGPETH. 1968. *Between Pacific Tides.* 4th Ed. Stanford Univ. Press.

SMITH, G. M. 1969. *Marine Algae of the Monterey Peninsula California.* Stanford Univ. Press.

L. C. COLT, JR.
BOSTON STATE COLLEGE
BOSTON, MASS. 02115

STEVEN SWARTZ
PACIFIC MARINE STATION
DILLON BEACH, CALIF. 94929

NEW RECORD FOR THE YELLOW LADY'S SLIPPER ORCHID, CYPRIPEDIUM CALCEOLUS L. SUBSP. PARVIFLORUM (SALISB.) HULT., FROM ALASKA. In 1964, while at the University of Alaska, I was asked by Mr. Ross Brockman to identify a collection of plants from the Bettles River area about 20 miles northeast of Wiseman (ca. 67°36′N, 149°40′W), in the Brooks Range region of Alaska. Among these plants was a yellow orchid which at that time I mistakenly determined as *Cypripedium guttatum* Sw., using Hultén's (1943) Flora of Alaska and Yukon, part 3. A recent reexamination of this specimen clearly reveals it to be *Cypripedium calceolus* L. subsp. *parviflorum* (Salisb.) Hult. This species is reported by Hultén (Flora of Alaska and Neighboring Territories, 1968, p. 316) from as far northwest as the upper Salmon Fork River area (about lat. 67°), Yukon Territory near the Alaskan border. The present collection (Ross Brockman, 26 June 1962, ALA) thus constitutes the first report of this species from Alaska and represents about a 250 mile westward and nearly a 100 mile northward range extension in North America. The specimens were from a colony of about 100 plants found at the well-drained, rather rocky, base of a limestone knoll near Bettles River. At this locality, *Cypripedium calceolus* occurred in a drier situation and bloomed earlier than the more common white lady's slipper, *C. passerinum* Rich.

VERNON L. HARMS
FRASER HERBARIUM
UNIVERSITY OF SASKATCHEWAN
SASKATOON, SASKATCHEWAN

INSTRUCTIONS FOR CONTRIBUTORS TO RHODORA

Manuscripts must be double-spaced or preferably triple-spaced (not on corrasable bond), and a list of legends for figures and maps provided on a separate page. Footnotes should be used sparingly, as they are usually not necessary. Do not indicate the style of type through the use of capitals or underscoring, particularly in the citations of specimens, except that the names of species and genera may be underlined to indicate italics in discussions. Specimen citations should be selected critically especially for common species of broad distribution. Systematic revisions and similar papers should be prepared in the format of "The Systematics and Ecology of Poison-Ivy and the Poison-Oaks," W. T. Gillis, Rhodora 73: 161-237, 370-443. 1971, particularly with reference to the indentation of keys and synonyms. Papers of a floristic nature should follow, as far as possible, the format of "Contribution to the Fungus Flora of Northeastern North America. V.," H. E. Bigelow & M. E. Barr, Rhodora 71: 177-203. 1969. For bibliographic citations, a recommended list of standard journal abbreviations is given by L. Schwarten & H. W. Rickett, Bull. Torrey Bot. Club 85: 277-300. 1958.

Volume 75, No. 803, including pages 325-492, was issued October 15, 1973.

CONTENTS: — *continued*

An Unusual Substrate for Polysiphonia paniculata Montagne
L. C. Colt, Jr. and Steven Swartz 488

New Record for the Yellow Lady's Slipper Orchid, Cypripedium calceolus L. subsp. parviflorum (Salisb.) Hult, from Alaska
Vernon L. Harms 491

Instructions for Contributors 492

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by
ALBION REED HODGDON, Editor-in-Chief

ROLLA MILTON TRYON
RADCLIFFE BARNES PIKE
STEPHEN ALAN SPONGBERG
GERALD JOSEPH GASTONY
ALFRED LINN BOGLE
RICHARD EDWIN WEAVER

Associate Editors

Vol. 75 December, 1973 No. 804

CONTENTS:

A Partial History of the New England Botanical Club.
Richard A. Howard 493

The Systematic Value of Trichome Complements in a North American Group of Vernonia (Compositae).
W. Z. Faust and S. B. Jones, Jr. 517

The Morphology and Systematics of the Audouinella Complex (Acrochaetiaceae, Rhodophyta) in Northeastern United States. *Wm. J. Woelkerling* 529

Book Review. *A. R. Hodgdon* 622

Instructions for Contributors. 624

Index. 625

The New England Botanical Club, Inc.
Botanical Museum. Oxford St.. Cambridge. Mass. 02138

RHODORA.— A quarterly journal of botany, devoted primarily to the flora of North America and floristically related areas. Price $10.00 per year, net, postpaid. in funds payable at par in the United States currency at Boston. Some back volumes, and single copies are available. For information and prices write RHODORA at address given below.

Scientific papers and notes, relating directly or indirectly to the plants of North America, will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. All manuscripts should be double-spaced throughout. Please conform to the style of recent issues of the journal. Illustrations can be used only if the cost of engraver's blocks is met through the author or his institution. Forms may be closed five weeks in advance of publication. Extracted reprints, if ordered in advance, will be furnished at cost.

Address manuscripts and proofs to Albion R. Hodgdon,
Dept. of Botany, Nesmith Hall, University of New Hampshire,
Durham, New Hampshire 03824

Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of March, June, September or December.

Second Class Postage Paid at Boston, Mass.

MANUFACTURED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Vol. 75 December, 1973 No. 804

A PARTIAL HISTORY OF THE NEW ENGLAND BOTANICAL CLUB

RICHARD A. HOWARD

The four hundred and seventy-third meeting of the New England Botanical Club, being the seven hundredth since the original establishment, was held at the Harvard Faculty Club, Cambridge, Massachusetts on April 6, 1973, as a dinner meeting. One hundred six members and guests were present. Dr. Wesley Tiffany presided. Dr. Gordon DeWolf, program chairman, arranged the evening celebration. At the head table were the senior members of the Club who were able to be present: Ralph Bean (elected 1909), G. Safford Torrey (elected 1912), Donald White (elected 1913), Henry Svenson (elected 1919), W. H. "Cap" Weston (elected 1921), Ralph Wetmore (elected 1927), and Hugh Raup (elected 1929), the officers, the speaker and their wives. A printed menu was available, as was a souvenir program, prepared by Dr. DeWolf, which contained a reprint of an address by Emile F. Williams on the occasion of the tenth anniversary of the Club, a summary of meeting places, and a roster of the officers and committee chairmen who have served the New England Botanical Club during the years. I was asked to "reminisce" as the presentation of the evening. Although I am not the oldest member of the Club by a good many years, I did have a few kodachrome slides of earlier years, and I supple-

mented these with some investigations into the history of the Club. Regrettably, the first four volumes of the minutes of meetings of the Club have been "misplaced" for many years. They have since been found, so the following material is not exactly what was said in the course of the evening but amplified in part.

In 1894 Mr. Warren H. Manning, a landscape architect in Boston, called a meeting at the old Horticultural Hall in Boston of the local botanists in order to ask their cooperation in assembling an herbarium of the plants of the Boston Metropolitan Parks. This may have planted the idea of a club of New England botanists. Manning noted that almost all assembled had to be introduced to each other. His task was to prepare a list of the plants growing in the local parks. Such a flora was published eventually by Walter Deane.

On December 4, 1895, Professor W. G. Farlow and Dr. B. L. Robinson invited seventeen gentlemen to meet on December 10 to consider the advisability of forming a botanical club. One of the invitations preserved in the Club archives specifies: "My house is 24 Quincy Street, next door to the Colonial Club. The cars stop at Quincy Square (Beck Hall)." On the site of Farlow's house now stands the Carpenter Center. The Colonial Club was replaced by the Harvard Faculty Club. Beck Hall was on the location of the Gulf Station on Massachusetts Avenue, and the name Quincy Square is no longer used. Thus, the seven hundredth meeting was held next door to the original gathering place where these men formed the New England Botanical Club. A second meeting within a month reaffirmed the decision to form a botanical club, and the NEBC was officially christened on February 5, 1896, at a third meeting. The charter members were seventeen in number. At the fourth meeting in March, 1896, Messrs. Fernald, Fuller, Greenman, J. R. Jack, Manning, John Robinson, and Rich from Boston were elected members, and the first non-resident members, Sears and Bailey of Providence and Jackson of Worcester, were elected.

The early meetings were held in members' homes, Farlow, Sargent, and Goodale being cited as excellent hosts. Later in 1896 the Club met at Young's Hotel on Court Street; from November 6, 1896 to December 4, 1903 at the St. Botolph Club on Newbury Street; from 1904-1906 at the Hotel Brunswick on Boylston Street; from 1907-1923 at the Twentieth Century Club on Joy Street, and from 1924-1954 at the American Academy on Newbury Street, all in Boston. Since 1954 the NEBC has met at the Harvard University Herbaria in Cambridge.

The Founders

The charter members of the NEBC were seven professional botanists and ten amateurs. Although biographical sketches of some are published in *Rhodora*, not all charter members are so recorded. Their contributions to the NEBC, to botany of New England, and to botany at Harvard are so great that a brief review of these founders seems to be in order. They lived to an average age of seventy-seven years, supporting the oft-quoted statistic on the longevity of botanists.

Joseph Richmond Churchill — 1845-1933

(*Rhodora* 36: 1-7. 1934.)

A member of the class of 1867 at Harvard, Churchill studied botany under Asa Gray, but he specialized in law (Class of 1869) and was appointed a judge after only two years of private practice in 1871. He started collecting plants with his fiancée, Mary Cushing, and they jointly prepared five hundred numbers before their wedding. Churchill's personal herbarium of 13,313 specimens was left to the Missouri Botanical Garden through the influence of Jesse M. Greenman. However, Churchill had exchanged duplicates with Walter Deane, whose herbarium is in the NEBC. Churchill wrote a *Flora of Milton* (1887). His will contained a bequest of $1,000 for *Rhodora*.

Frank Shipley Collins — 1849-1920
(*Rhodora* 22: 96. 1920., *Amer. Jour. Bot.* 12: 54-62. 1926.)

An algologist with many articles on the subject to his credit, Collins was on the editorial staff of *Rhodora* for twenty-one years. Although an obituary was promised for *Rhodora*, only the death notice cited above ever appeared.

George Edward Davenport — 1833-1907
(*Rhodora* 10: 1-9. 1908.)

Best known for his contributions to the study of ferns in nearly one hundred articles, Davenport also specialized on the general flora of Middlesex Fells and wrote a *Flora of Medford* (1875-1876). His collection of fern specimens was given to the Massachusetts Horticultural Society in 1875, and shortly after that he began a new personal herbarium. This his daughter gave to the Gray Herbarium after his death. Subseqently the earlier collections were given by the Massachusetts Horticultural Society to the Gray Herbarium.

Lorin Low Dame — 1838-1903
(*Rhodora* 5: 121:123. 1903.)

A principal of Lexington High School and subsequently of Medford High School for a total of twenty-seven years, Dame collected in the Lexington area and on Nantucket. He is best remembered for his books, "Typical Elms and Other Trees of Massachusetts" (1890) and the "Handbook of the Trees of New England" (1902).

Walter Deane — 1848-1933
(*Rhodora* 35: 69-80. 1933.)

Deane was a graduate of Harvard, class of 1870, and taught in the private schools of St. Mark's and Hopkinson for twenty-five years. He became interested in botany in 1880 and worked hard on the flora of the Boston Park System for the M.D.C., for which he compiled an herbarium which became the first large accession of the NEBC. He

also helped curate the ornithological collection of William Brewster and helped issue the "Birds of the Cambridge Region" (1906). His first herbarium specimen was identified by Asa Gray as *Gerardia purpurea* and is in the Club herbarium. Deane collected with Kennedy and Churchill and was a long time friend of L. H. Bailey. He bought and exchanged specimens and built up a personal herbarium of 40,000 sheets. The early lists of distributions of New England plants were often based on his meticulous records. Walter Deane also gathered New England specimens which were to serve as the models for the Blaschka glass flowers being assembled by Goodale.

Deane served on the first Visiting Committee of the Gray Herbarium and helped Robinson plan the building constructed in the Botanic Garden in 1915, donating his personal library to the Gray Herbarium in 1918. He assembled an extensive collection of portraits of botanists. On his seventy-fifth birthday (1923) the members of the NEBC, as a surprise to him, collected $1,000 which was presented to the Club as a library fund in Deane's honor. His will contained bequests to the Club and to the Gray Herbarium.

William Gilson Farlow — 1844-1919
(*Rhodora* 22: 1-8. 1920.)

Although Asa Gray had been asked much earlier to organize a club of amateurs and professionals for the study of the New England flora, he did not feel it was worthwhile. It was Professor William G. Farlow who called the first meeting at his home, the start of the NEBC.

Farlow studied with Gray, graduated from Harvard College in 1866, and obtained an M.D. degree in 1870. For two years he worked at the Gray Harbarium, but in 1874 he joined the staff of the Bussey Institution. He wished to specialize on algae and his report of 1879 on algae in Massachusetts water supplies is regarded as a classic. In 1879 Farlow announced his intentions of leaving his library and herbarium to Harvard. In his will, probated after

his death in 1919, Farlow had stipulated that his collections were to be removed from the flammable Agassiz Museum and properly housed within three years or the collections would be given to Yale. Three months before the time limit expired, the University chose the Divinity School Library building as the location. That building and the collections have since been known as the Farlow Herbarium and Library. Until her death some years later, Mrs. Farlow financed the operation of this collection.

Charles Edward Faxon — 1846-1918
(*Rhodora* 20: 117-122. 1918.)

Faxon was one of a family of linguists but is best known as an artist. He taught himself to draw and was making saleable copies of Audubon's work at the age of 15. Although he was trained as a civil engineer at the Lawrence Scientific School, he took a position as instructor in botany at the Bussey Institution in 1879. There D. C. Eaton asked him to prepare drawings of ferns. By 1882 his work had come to the attention of Charles Sargent who lured him to the Arnold Arboretum where he prepared seven hundred and forty-four plates for the *Silva of North America.* Between 1879 and 1913 Faxon published 1,925 plates of his botanical art, an average of fifty-seven illustrations a year for thirty-four years. Faxon also translated botanical work for Sargent from Portuguese, Italian and Danish, several of which are published. His personal writings were few, a paper on birds in the Arnold Arboretum and a note on *Aster.*

Edwin Faxon — 1823-1898
(*Rhodora* 2: 107-111. 1900.)

This Jamaica Plain bachelor was a leather merchant who retired at the age of fifty-eight and devoted much of his time to collecting plants. His early botanical forays were with C. Pringle in Vermont, and he devoted time to the area of Lake Champlain, Mount Washington and Mount Desert Island. In 1890 Faxon translated from the German

an important monograph of *Sphagnum* through a contact with D. C. Eaton. He continued this interest, assembling and distributing large exsiccatae of mosses. It is reported that Faxon was one of the most knowledgeable individuals of his time on the entire flora of New England.

George Lincoln Goodale — 1839-1923
(*Rhodora* 25: 117-120. 1923.)

A graduate of Bowdoin College, Goodale received an M.D. degree from Harvard in 1863. He taught at Bowdoin, practiced medicine, farmed, wrote on animal breeding, and formed a company to make condensed milk. In 1868 he published a catalogue of the plants around Portland, Maine, and in 1872 joined the Harvard faculty upon Asa Gray's retirement to teach classes in botany. During this period he also wrote the physiological section of Gray's Botanical Textbook. In 1879 Goodale was appointed director of the Botanic Garden of Harvard, succeeding Sargent in that role, and Curator of the Botanical Museum. His text of "Wild Flowers of America" (1882) was supported by Isaac Sprague's drawings. In 1897 Goodale tired of having his Botanic Garden income support the Gray Herbarium and asked that they be separated. The Corporation approved, and Goodale turned his attention to the development of the Botanical Museum closer to the University.

George Golding Kennedy — 1841-1918
(*Rhodora* 21: 25-38. 1919.)

A graduate of Harvard in 1864, with an M.D. in 1867, Kennedy had been a student of Asa Gray and was influenced by him. Although a successful practicing physician, Kennedy found time to travel and collect plants over the years with Fernald, Churchill, Collins and Williams. The early gatherings of the NEBC members were held at his home between the regular meetings. His group became known as the "Faxon Club" for which no records seem to be available. Kennedy's personal herbarium contained 14,390 sheets of flowering plants and a large collection of mosses.

He was known for his special knowledge of the flora of Willoughby, Vermont which was published in *Rhodora* (1904).

He served as a member of the Visiting Committee of the Gray Herbarium and in 1896 he generously supplied funds for the construction of the library wing.

Nathaniel Thayer Kidder — 1860-1938.
(*Who Was Who in America 1897-1942* p. 673. 1942.)

No obituary of Kidder appeared in *Rhodora,* even though he was the only member of the Club to serve two distinct terms as president, in 1896-9 and 1902-05, and the only president to serve for six years. A bachelor, he lived in Milton. His few botanical papers covered the flora of Milton and the Blue Hills, with another on the plants of the Isle au Haut. The Kidder wing of the Gray Herbarium was his gift in 1910 as a member of the Visiting Committee.

Edward Lothrop Rand — 1859-1924
(*Rhodora* 27: 17-27. 1925.)

Rand was graduated from Harvard College in 1881 and obtained a degree in law in 1884. He was successful in his profession. As a Harvard junior, he camped at Somes Sound on Mount Desert Island and was one of the youthful naturalists who formed the Champlain Society to prepare a natural history catalogue of the area. The first edition of his *Flora of Mount Desert Island* omitted the difficult grasses and sedges, but the fourth edition published in 1894 with J. H. Redfield, a friend of Asa Gray, was complete. A bronze plaque on a large boulder on the Jordan Pond trail on Mount Desert commemorates Rand's contributions to the knowledge of that flora.

Rand served as corresponding secretary of the NEBC from 1895 to 1921 and was the mainstay of the publications committee in soliciting funds and manuscripts for *Rhodora*. His personal herbarium, left to the NEBC in 1915, contained over 15,000 sheets.

Benjamin Lincoln Robinson — 1864-1935
(*Nat. Acad. Sci. Biographical Mem.* 17: 305-330. 1937.)

Although he was the editor of *Rhodora* for the first thirty volumes, president of the NEBC, the Curator and later Director of the Gray Herbarium, no obituary of Robinson ever appeared in *Rhodora.*

Robinson began his college career at Williams College, but after three months he was dissatisfied and entered Harvard, graduating with the class of 1887. With a young bride, he went to Strasburg, Germany where he received his Ph.D. degree in plant anatomy in 1889. Between 1891 and 1894, he taught scientific German at Harvard. On the death of Sereno Watson in 1892, Robinson was appointed Curator of the Gray Herbarium at the age of twenty-nine. When the Harvard Corporation approved Goodale's request that the Botanic Garden be separated from the financially insolvent Gray Harbarium in 1897, Robinson was forced reluctantly to raise money. Mrs. Asa Gray donated $20,000 in 1899 to establish a professorship honoring her late husband, and Robinson was the first occupant of that chair. With the help of a "friends" organization having a basic membership fee of $10 in 1897, Robinson was able in his career to increase the endowment of the Gray Herbarium from $18,000 to $526,000. Since the other Harvard botanists were located in the Agassiz Museum area, Robinson also requested permission from the University to move the work and the collections of the Gray Herbarium into "the city" to be adjacent to the cryptogamic collections and the Botanical Museum. Although President Eliot approved this proposal in 1900, the Friends of the Gray Herbarium and the members of its Visiting Committee were opposed and no funds were raised. By 1905 Robinson drew a pathetic description of the housing of Gray's collections. In his annual report he wrote that the building was partially fireproof, ill-lighted even in the daytime, poorly ventilated, with inadequate plumbing of an archaic and wholly unsatisfactory type, had no basement under much of the

building so that the lower cases were so damp as to cause molding of the specimens, the roof was ill-constructed that more than forty years of repair had never made it tight for more than a few weeks at a time, and so a wholly new struture was needed. In 1909 the University approved the idea of expanding and renovating the existing buildings if funds could be raised for the purpose. Robinson and Deane drew the plans. It is worth noting that over half of the members of the Visiting Committee at that time were members of the New England Botanic Club whose herbarium was then housed in these same quarters. They responded with gifts and supported additional fund raising. Kidder supplied the initial gift which built the addition known as the Kidder Wing. A message congratulating Kidder for this gift appears in the Club records. A member of the Harvard Corporation offered $2,000 for Asa Gray's house which was unoccupied, and this was moved across Garden Street to its present location. The gavel used by subsequent presidents of the NEBC was turned from a corner post of this building. George Kennedy next gave $25,000 for a library wing which developed the Gray Herbarium toward the Garden Street side. George White then donated $21,500 for the construction of a new laboratory to replace the Hunnewell Laboratory in the opposite direction. In addition, $10,000 was offered for equipment. Kennedy again donated funds, $10,000 this time, to add a new facade to the old building. As the last construction, three members of the Visiting Committee supplied funds to rebuild the center part of the building into three galleries and a basement, completing the building as most of us knew it before 1940. Construction was finished and the building occupied in February of 1915. The minutes of the NEBC reveal that a meeting was held in the building, that the members were delighted with the new quarters for the Club herbarium, and that the entire structure was "brilliantly lighted throughout with electricity".

Robinson's research centered on the Eupatoriae of the Compositae, and he made a major contribution in a study of the flora of the Galápagos Islands. His editorship of *Rhodora* demonstrated that he was a perfectionist in his writing. He was also a versatile linguist with a knowledge of many languages. Dr. Lily M. Perry recalls his reviewing his use of Hungarian, anticipating visiting with Dr. C. Domin because he felt it would be nice to speak to Dr. Domin in his own language. He is remembered to this day as a kind and gentle man with a formal courtesy, a gentleman of Harvard.

Charles Sprague Sargent — 1841-1927

(*Jour. Arnold Arb.* 8: 69-86. 1927.)

Sargent is best remembered as the first Director of the Arnold Arboretum. He served in that capacity for fifty-four years and built up a remarkable institution soundly based on a library, an herbarium, and a living collection. Although a charter member of the NEBC, he never served in any official capacity. Several of the summer outings of the Club were under his auspices, all with the same itinerary: to Forest Hills by railroad, thence through the Arnold Arboretum and around his home in Brookline in carriages which he supplied.

Roland Thaxter — 1858-1932

(*Nat. Acad. Sci. Biographical Mem.* 17: 55-68. 1936.)

Thaxter was graduated from Harvard College in the class of 1882. His thesis had been on entomogenous fungi, and this proved to be his life work. He was appointed assistant professor of cryptogamic botany in 1891 and succeeded William G. Farlow as a professor in 1901. Thaxter served as president of the Club, was one of the frequent speakers for the monthly programs, and was one of the first to offer a botanical travel talk involving his work in the West Indies.

Benjamin Marston Watson — 1848-1918

(*Records of the Harvard class of 1870*, pp. 144-145.)

After his graduation from Harvard, Watson operated a nursery in Plymouth, Massachusetts, started by his father. In 1877 he was appointed an instructor in horticulture at the Bussey Institution where he taught arboriculture, fruiticulture and later landscape design. Although a charter member of the NEBC, he never held office and was never mentioned in the club minutes as a speaker or a participant.

Emile Francis Williams — 1858-1929

(*Rhodora* 33: 1-18. 1931.)

Williams spent his childhood in France and inherited a profitable import business from his father. His spare time was spent hiking in the White Mountains where, on one occasion, he met G. G. Kennedy collecting plants. When the NEBC was organized, Williams became the original secretary-treasurer, a role he continued to fill from 1896 until the Club was incorporated in 1922. He served on the editorial committee of *Rhodora* and was largelv responsible for raising money to meet its annual deficit. In the early years the Club published annual booklets containing the Constitution and a list of the officers and members of the Club, which he edited. His obituary contained a detailed account of his gracious hospitality and the fine table he set at the dinners for members before the formal meetings of the Club. Throughout his life he was an active collector, especially on Mount Katahdin, joining all the club excursions and traveling with Fernald in Maine and Canada. His herbarium came to the NEBC in 1916.

No mention of the New England Botanical Club and its early history would be complete without comments on two individuals who made significant contributions to its development: Mary Anna Day and Merritt Lyndon Fernald.

Mary Anna Day — 1852-1924

(*Rhodora* 26: 41-47. 1924.)

The New England Botanical Club was a gentlemen's

organization, and Miss Day was not eligible for membership. She was a teacher and served as librarian in the Clinton, Massachusetts, public library. She sought a position at Harvard just as Miss Josephine Clark left the library of the Gray Herbarium for a position in Washington. Miss Day was appointed in 1893, and her first task was checking all the five thousand references in Gray and Watson's Synoptical Flora. When the New England Botanical Club was formed, Miss Day compiled lists of the existing local floras and of the known private and institutional herbaria of New England which were published in the original volume of *Rhodora.* For years after that she prepared the Index for the annual volumes of *Rhodora.* Although not a botanist, Miss Day was interested in plants and collected many of the early exsiccatae of the Gray Herbarium. In 1903 she took over the task of preparing the Gray Herbarium index cards and was responsible for the issuance of over 170,000 cards. Hers was also the task of organizing the library of the Gray Herbarium in the construction period of 1909 to 1915. She is mentioned occasionally in the minutes of the Club as an aid or consultant on the acquisitions for the Club library. A tribute to her life and contributions was published in *Rhodora.*

Merritt Lyndon Fernald — 1873-1950
(*Rhodora* 53: 33-65. 1951.)

Young Merritt Fernald came to the Gray Herbarium from his home in Maine in 1891 at the age of 18 and served as an assistant to Sereno Watson, curator of the Gray Herbarium until 1902. He was not a charter member of the New England Botanical Club but was among the first new members elected during the fourth meeting on March 4, 1896. Fernald immediately became active in the Club, working hard to establish the herbarium and contributing his observations regularly to the Club meetings, even guiding the amateurs in the proper preparation of specimens and in the identification of plants. At the tenth annual meeting of the Club, December 1, 1905, Emile Williams was asked to give "a little history of the Club, its

origin and development." This was printed separately and is a memento in the Club records. Of the herbarium Williams wrote, "The herbarium of the Club is one of its best institutions. Dr. Robinson can tell you how useful it has become. We owe a large debt of gratitude to Mr. Fernald for his labors in this direction, as well as in every other. How could we get along without Mr. Fernald? The devoted Mr. Fernald, always ready to stand in the breach, to supply an extra number for *Rhodora*, to deliver an address at one of our meetings."

Fernald was officially the "Phanerogamic Curator" from 1899 to 1911 and served then in succession as President (1911-1914), as Councillor (1914-1928), and as Editor of *Rhodora* from 1929 until his death in 1950. Short and paunchy, as I first knew him, Fernald remained bouncy and confident, a showman to the end. He livened the meetings of the New England Botanical Club through his contributions for over fifty-four years.

The Meetings

The goals of the original New England Botanical Club were many — to meet in a fraternity of gentlemen with a mutual interest in the plants of New England; to assemble an herbarium representing plant specimens from each county in the New England states; to prepare distribution lists of taxa to determine the ranges and the gaps of New England plants, and to publish a journal, *Rhodora*, for contributions on New England botany.

Initially the Club accepted nominations from its charter members for additional resident and non-resident members to be elected by written and secret ballot with a corps of "scrutineers" to count and report the ballots, a practice continued to this day. An induction fee was charged and dues were regularly assessed.

The fraternity of the meetings was obvious in good food, and often wines, served by a caterer following the formal meeting. At the June and October meetings all of the members were called upon, in order, to report on the

specimens of interest which they had found. Informal meetings for the insertion of specimens into the herbarium were well attended. Special conferences were conducted in the early years by Professor Fernald and others when groups of plants such as grasses, *Ranunculus,* sedges, ferns, aquatic plants were discussed in considerable detail, alerting the members to the characteristics and information to be sought in living specimens. Field trips were regularly scheduled to remote places needing concentrated collecting. Schedules of transportation, hotel reservations, etc., were issued in advance, and field work was well organized in assigned areas or details.

The NEBC continued its informal existence through two hundred twenty-seven meetings, until the tax laws of the Commonwealth became a concern and the club was officially incorporated in January of 1921. Since 1922 the secretary's minutes have begun as they do today, "The four hundred and seventy-third meeting of the New England Botanical Club being the seven hundredth since its establishment. . . . . ". Recording secretaries have been many, yet the quality of the reports through the years provides uniformly interesting reading of the activities of the Club; the election and comments of the members; the accounts of the principal speakers; the introduction of the first lantern slides or the first use of colored movies; the wartime trials and limitations such as cold meeting rooms to conserve coal or the substitution of cheese and crackers for luncheon plates in 1918; of deaths and touching tributes to members; of appeals for new members; or of the rising costs and budget deficits.

The Herbarium

The herbarium was begun with the original meeting and grew with regularity as members added specimens. Collections in private hands were sought out and acquired by the Club, and members usually bequeathed their own collections to the Club. A mounter was hired but club members inserted the specimens. Fernald once requested

paid help for the herbarium, but the suggestion was referred to the Council, which, according to the following records, never took any action. In 1926 the treasurer reported that the real cost of mounting and inserting a sheet in the herbarium was "well in excess of 5 cents" and therefore the investment in the herbarium was over $7,000. Today the Club herbarium houses 243,189 specimens.

The Club herbarium was originally housed in the Agassiz Museum. There was a long debate on where the key should be kept, in Dr. Farlow's office or with the janitor, and this was finally settled by having it in Farlow's home. The herbarium was available to members on a regular basis, including weekly evening hours. In 1905 the herbarium was moved to the original Gray Herbarium on Garden Street and in 1915 to new quarters in the White wing of the renovated building. Finally in 1954 the herbarium was moved to its present quarters in the Harvard University Herbaria building, 22 Divinity Avenue, Cambridge, where the monthly meetings are also held.

The survey of distribution of New England plants published periodically in the pages of *Rhodora* was begun by naming a family of plants with the request that the individual members check their private herbaria and bring the distribution records to a stated meeting. In later years the NEBC, by additions to its own herbarium, depended upon the faithful work of members to compile such listings. How well remembered is the work of Richard Eaton, Stuart Harris, Ralph Bean, Frank Seymour and Donald White to complete the lists published in the last decade!

Rhodora

The charter members of the NEBC considered carefully the formation of an official publication. By circulation of an invitation to subscribe, an original mailing list of six hundred was obtained. An editorial announcement in Volume 1, Number 1, January 1, 1899, stated, "Its publication has not been undertaken without mature considera-

tion, nor until through keen and helpful interest of New England botanists, a sufficient subscription list has been secured to assure its monetary support. The name *Rhodora*, although the designation of one of our most attractive New England plants, has been chosen, not from sentiment but primarily from a desire to have a distinctive and euphonious one-word title, experience having amply shown that similar titles (e.g., *Linnaea*, *Grevillea*, *Helios*, *Erythrea*, *Auk*, *Ibis*, etc.) soon become familiar, and possess great merit in their brevity and ease of citation." In fact, this decision and choice was reported amply in the records of the Club. B. L. Robinson was the spokesman for the one-word title, and a vote was taken on the choice of a name. Ballots were cast for *Rhodora*, *Oakesia*, *Watsonia*, *Bigelovia*, *Grayia* and *Nova Anglia*, in that order.

The original subscription to *Rhodora* was one dollar a year, with single copies priced at fifteen cents. Authors of more than one page were to receive twenty-five copies of the issues with reprints at cost. The early copies carried advertising. Members were invited to subscribe; the dues did not automatically include a subscription.

From the beginning *Rhodora* was a deficit operation. The initial subscription list dropped rapidly at the time of renewal, for many expressed the opinion that the journal was too technical. When the treasurer reported that the cost of *Rhodora* was four times the receipts from subscriptions, an appeal was made, at first annually and later triennially, for special gifts to subsidize the publication without the annual draft against the general funds of the Club. For a period manuscripts were rejected due to excessive maps or plates. As late as 1933 M.L. Fernald reported to the club, "Technical scientific journals do not pay their way. Intended for the permanent record of newly discovered truth, they must be issued at a price within reach of any who need access to them. Temporarily we are most fortunate in our support; but we must look to the future. The bequests already made by members of the Club who while with us took a keen interest in *Rhodora*

are comfortable nest eggs which greatly relieve the worries of the Treasurer and of the Editorial Board. Provisions in our wills for their multiplication will insure the future of *Rhodora;* but, since botanists as a group are long-lived, it is suggested that earlier additions to the permanent endowment of *Rhodora* may bring prompter and greater returns in satisfaction to the investors." Eventually several endowed funds for the support of *Rhodora* were received by the Club. *Rhodora* was edited by B. L. Robinson for Volumes 1-30, M. L. Fernald for Volumes 31-52, R. C. Rollins for Volumes 53-63 and A. R. Hodgdon for Volumes 64-75. The Club has been fortunate in having this small, dedicated group of voluntary and unpaid editors.

The Archives

The Club has a long history partly preserved in the minutes of the meetings and partly as archival material. Various people over the years contributed newspaper clippings, photographs, cartoons, poetry, letters or miscellaneous mementos. Recently the current Club librarian, M. Canoso, has attempted to organize the material on hand. A series of undated photographs of members appear to be associated with an appeal made by Mr. Bullard, as recorded in the minutes of October 4, 1934 for "all members who had not yet had their photographs taken for the club records to send to him a suitable likeness so as to complete this branch of the Historical Committee's work." Kodachrome slides made of these early photographs accompanied this presentation on the occasion of the seven hundredth meeting.

One of the oldest of the "poems" long associated with the New England Botanical Club was attributed to Edward L. Rand in 1900 and is available in a much duplicated form. Although it has been read on occasions, the original was considered lost with the older records. Now it can be dated in the minutes, having been read first on March 2, 1900. "Verses by Edward L. Rand inspired by the following statement of Mr. Fernald in *Rhodora* 11-39. 'Mr.

Walter Deane informs me that in his youth he was familiar with Old Orchard Beach and that at that time this *Artemesia* (*A. stelleriana*) was not seen'."

Me Judice

In the youth of Walter Deane, in those glorious ancient days,
Foreign plants had not crept in with insinuating ways.
Every plant was then our own, from each rootlet tip so small
And the old world floral tramps did not cut a dash at all; —
All our plants were indigene
In the youth of Walter Deane.
In the youth of Walter Deane, gardens were not hard to weed;
Our plants were too polite to promiscuously seed,
And profanity produce. Foreign weeds grew only then
In ash barrels far remote, — rarities were they to men.
Shepherd's-purse grew not, I ween,
In the youth of Walter Deane.
Little Walter on the wharves used to sit from day to day,
Waiting for the ships to bring plants from lands so far away,
Dandelions, buttercups, white weed, chickweed, — all were new, —
With a thousand other things, well known plants to me and you.
These, remember, were first seen
Since the youth of Walter Deane.
Long ago these days have fled. Walter to a man has grown
All the floras of the world now contribute to our own.
Yet confusion can't arise, all new comers one by one
Have been noted by our friend since their inroad first begun;
So we know what's indigene
From the words of Walter Deane.

The twentieth anniversary meeting of the Club was re-

ported in the minutes of February 4, 1916. "Mr. Edward L. Rand, the recognized bard of the Club, an office not in the Club book but which so far no one has ventured to compete for against him, read the following verses which he too modestly calls a skit."

As I was walking through a field
The habitat was wet
I chanced to see a winsome thing
The modest Violet.

She looked familiar. Once I knew
Her given name — I think
But now we know these plants seem named
By influence of drink.

Her color was what poets call
"A bit of Heaven's own blue"
But this is very, very wrong
As Mathews shows to you.

"Dear Flower," I said, "I love you well.
Yourself pray introduce."
She bowed her head and murmured low,
"It would not be much use.

"A man who lives up in Vermont
'Freakish' calls me and 'cross'
And says no one respectable
Can guess what is my source.

"A nameless nothing sure am I.
Forget your love for me
Until I find out who I am
In plant society."

I could not comfort her, alas,
For specialistic ways
Must hurt the feelings of the plants
In these intensive days.

I had to leave her to her grief,
For versed not am I
In dead names that are brought to life
And living names that die.

No comfort lies in synonyms, —
But how nice it would be
If she could have the novum nom
of V. brainerdii.

This poem ribbing the very active members of the Club, Vermont specialist on *Viola*, Ezra Brainerd, and F. Schuyler Mathews, of "Wild Flower" fame was followed by a song "which will doutless become a classic at celebrations of the New England Botanical Club." It is entitled "Segregation Song", and needless to say it is the work of Edward L. Rand. This was sung by the whole club under the leadership of Harold St. John. Sung to the tune of "My Bonnie", the first of six verses is:

The deuce of a genus is *Aster*, intermediates come by the score
"Destroy them at once", says the wise man, else there will be species galore.

Chorus
Segre —, Segre —, Segregation is a terrible bore
Bring back, bring back, oh, bring back our species of yore.

At this same meeting Mr. Rand also made the following announcement in verse:

If anyone knows a man who would enjoy the Club
And whom the members might enjoy, whose home is near the Hub,
Throw off this girlish bashfulness, and send his name to me.
I'll take it to the Council, so he may elected be
(We really need a lot of names, for it would be a winner
If we could make new members pay the bill for this great dinner.)

The twentieth meeting concluded with another song with words by Rand and sung to the tune of John Brown's Body. The verses were a parody on the many talks given by M. L. Fernald, and two of them are worthy of quotation.

In old times the Bryan Vikings voyaged far across the foam
Just to find the genial grapejuice, as is stated in the poem.
How that juice must have fermented — do you think they brought it home?
Rhodora tells it all.

Chorus

Glory, glory to New England
Glory, glory to New England
Glory, glory to New England
and our N.E.B.C.

Now for all these great achievements which our Club may justly claim
We must give great praise and credit, else we should be much to blame,
To that man who led us onward, M. L. Fernald is his name.
Rhodora tells it all.

Although a "bard" has not appeared in the Club in recent years, there is an anonymous short poem often quoted at the Club even in his time, to the delight of its victim the Latin scholar and ex-college president, Arthur Stanley Pease. George R. Cooley recorded this in a letter to Richard Eaton in 1959.

Here lies the body of Stanley Pease
Buried beneath the venerable trees
What lies here is only the pod
Pease shelled out and went to God.

Although the New England Botanical Club was originally a gentlemen's organization, there is a reference in the minutes of the meeting of May 7, 1915, to "our one lady member." Who this female member might be cannot be

determined by a check of the club books of the year. On the occasion of the fifieth anniversary of the Club in 1946 greetings were received from the California Botanical Society which prompted the following poetic response from E. J. Palmer.

We thank you for the good intent
Of the kind sentiments you sent
When this distinguished club of Men
Had reached the age of two-score-ten.

Back in the days when men were men
And botanists were gentlemen,
They loved their wives and sisters too —
As we do still, as well as you.

But there were times — the saints be thanked
Our fathers felt were sacrosanct,
And spots to which they might retreat
That were forbid to female feet;

Where they might gather and regale
On wisdom spiced with salty tale,
Secure and sure *they* wore the pants
And not the wives and spinster aunts.

We, sons of sires of those brave days,
Still follow in their prudent ways;
And so as was the founders' plan,
There are no sisters in our clan.

So pardon us, if we should quote
One slight faux pas in your kind note,
When you address — by slip of pen —
As a "sister club", this club of Men.

1973

However, times have changed, and in 1968, after much agonizing debate, the New England Botanical Club amended its by-laws to admit women. With good taste, recent presidents have not asked the lady members to serve on the

refreshment committee or to pour tea. In fact, one of them is now the recording secretary and another the phanerogamic curator. Meetings in 1973 close not with dinners, or the tub of ice cream so popular with the student members when I joined the club, but with beer of many varieties and ginger ale for those who so choose, accompanied by doughnuts and cheese and crackers. *Rhodora* is now a quarterly containing a larger number of extra-territorial papers. Council meetings precede the regular meetings since many of the officers travel distances to attend which would be beyond the comprehension of the founders of 1895. The herbarium still needs volunteers to insert specimens or to check distribution records. The June and October meetings have been termed "show and tell" sessions but are still enjoyed by those attending. Above all, good fellowship prevails and a mutual interest in the flora of New England forecasts a long life for the New England Botanical Club.

ARNOLD ARBORETUM OF HARVARD UNIVERSITY
JAMAICA PLAIN, MASS. 02130

THE SYSTEMATIC VALUE OF TRICHOME COMPLEMENTS IN A NORTH AMERICAN GROUP OF VERNONIA (COMPOSITAE)

W. Z. FAUST AND S. B. JONES, JR.

Trichomes are among the most useful of all anatomical features for systematic comparisons of angiosperms. This is because of their variety, their wide occurrence, their ease of preparation for study, and sometimes their close correlations to variation patterns among the taxa (Carlquist, 1961). The characteristic forms of trichomes are often of considerable value in recognition of genera (Heintzelman & Howard, 1948), and certain distinct types of trichomes may be used as criteria for distinguishing species (Cowan, 1950; Goodspeed, 1954). In *Nicotiana*, Goodspeed (1954) found that the trichome complement is of phyletic significance because the types of trichomes point to species origins and relationships. The trichome complements in *Nicotiana* are correlated with patterns of morphology, geographical distribution, and cytogenetics. Cowan (1950) demonstrated that trichomes are a reliable guide to relationships and classification in *Rhododendron*.

Uniseriate trichomes as well as a variety of multicellular glandular and non-glandular trichomes are widely distributed in *Vernonia* (Solereder, 1908). Hunter and Austin (1967) demonstrated the hybrid origin of a *Vernonia* taxon by a comparison of the trichome complement of the two parental species and their hybrid progeny. They suggested that a study of the trichomes of other species of *Vernonia* might be of taxonomic significance. Urbatsch (1972), Faust (1972), and King (1971), working on systematic problems among the species of *Vernonia* native to the United States, found evidence that trichomes are of systematic value in the genus. In 1923, Gleason erected a series of hypotheses on migration and evolution of *Vernonia* in North America. These hypotheses provide a basis of comparison for studies of trichome patterns and schemes

of phyletic groupings. More recently, *Vernonia* has been the subject of a series of biosystematic and biochemical investigations by Jones and his students and by Abdel-Baset and Padolina in Dr. Tom Mabry's laboratory at the University of Texas. These later studies have provided additional data and an opportunity to refine Gleason's hypotheses.

Living material of 21 taxa of a closely related group of *Vernonia*, the *Paniculatae verae*, from the Sierra Madre Oriental of Mexico and from the eastern one-half of the United States were available in the greenhouse. This provided an opportunity to determine whether or not trichome complements might provide information useful in the classification of these *Vernonia* species. This evidence along with other data from biochemical systematics, transplant studies, hybridization experiments, and population analyses will eventually be combined into a taxonomic revision of the subsection *Paniculatae verae*.

MATERIALS AND METHODS

Mid-cauline leaves of each taxon collected from greenhouse grown transplants were fixed in FPA (formaldehyde, propionic acid, and alcohol) for anatomical comparisons. Whole mounts of leaves were cleared in 1% aqueous NaOH at 60°C and transferred to 75% lactic acid at 60°C until completely cleared. The leaves were then stained in safranin and fast green and mounted in Hoyer's solution. Leaves from herbarium specimens were cleared in the same manner for additional observations. Leaf cross-sections were prepared by dehydrating in an ethyl alcohol-butanol series, embedding in paraffin, and sectioning at 12 μ. The sections were stained with safranin and fast green. Fresh whole mounts of the leaves, 3 mm^2, were examined by scanning electron microscopy. The whole mounts were glued onto the specimen stubs with a mixture of Elmer's Glue-All and silver conductive paint. Micrographs were made of the trichome types. Paired affinity indexes were constructed for the trichome complement of the lower leaf surfaces as

TABLE 1. Leaf trichome complements of 21 taxa of *Vernonia*.

Taxon[1]	Trichome type[2]							
	Bilobed	Awl-shaped	Awl-shaped glandular	L-shaped	L-shaped glandular	T-shaped	Uniseriate	Longhorn
V. schaffneri	B	B	L				U	
V. greggii	B	L	L				U	
V. ervendbergii	L	B					B	
V. texana	B	U	L				B	
V. arkansana	B	B	B				U	
V. angustifolia	B	L	L				U	
V. pulchella	L	B	B				B	
V. glauca	B	L	L				U	
V. larsenii	B		L					B
V. lindheimeri	B		L					B
V. flaccidifolia		L		L	B		U	
V. lettermannii	B		L					
V. noveboracensis	B	L	L	B			U	
V. blodgettii	B	U	L	L				
V. acaulis	L	L					B	
V. gigantea	B	L	L	L			U	
*V. bald. ssp. bald.	B	L	L		L	L	U	
*V. bald. ssp. int.	B	L	L			L	B	
V. missurica	B	U	B	L			U	
V. fasciculata	B	L	L	U			U	
V. marginata	B	L	L	U			U	

[1]The taxonomic treatment is based on that of Gleason, 1922, as modified by Jones, 1964, 1970; Urbatsch, 1972; Faust, 1972; King, 1971.

[2]Occurrence on leaves is indicated by abbreviations: U = upper surface only; L = lower surface only; B = present on both surfaces.

*V. bald. ssp. bald = *V. baldwinii* ssp. *baldwinii*; V. bald. ssp. int. = *V. baldwinii* ssp. *interior*.

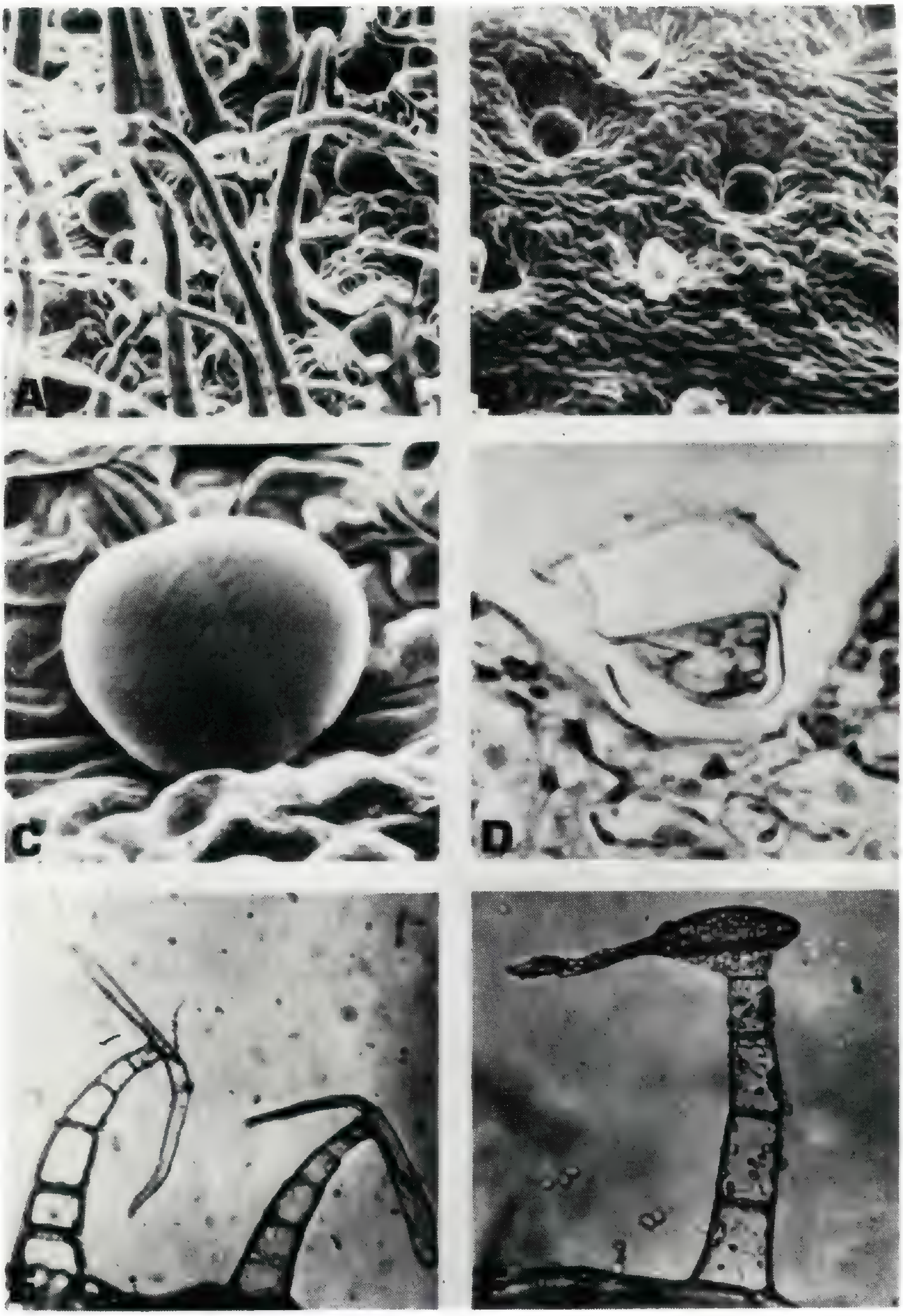


Figure 1. Trichomes on lower leaf surfaces of *Vernonia*: (A) SEM of *V. missurica* 100×, (B) SEM of *V. marginata* bilobed and awl-shaped types 100×, (C) SEM of *V. marginata* bilobed type 500×, (D) cross-section of *V. marginata* bilobed type illustrating basal cells 500×, (E) whole mount of *V. baldwinii* ssp. *interior* T-shaped type 400×, (F) whole mount of *V. baldwinii* ssp. *baldwinii* L-shaped glandular type 400×.

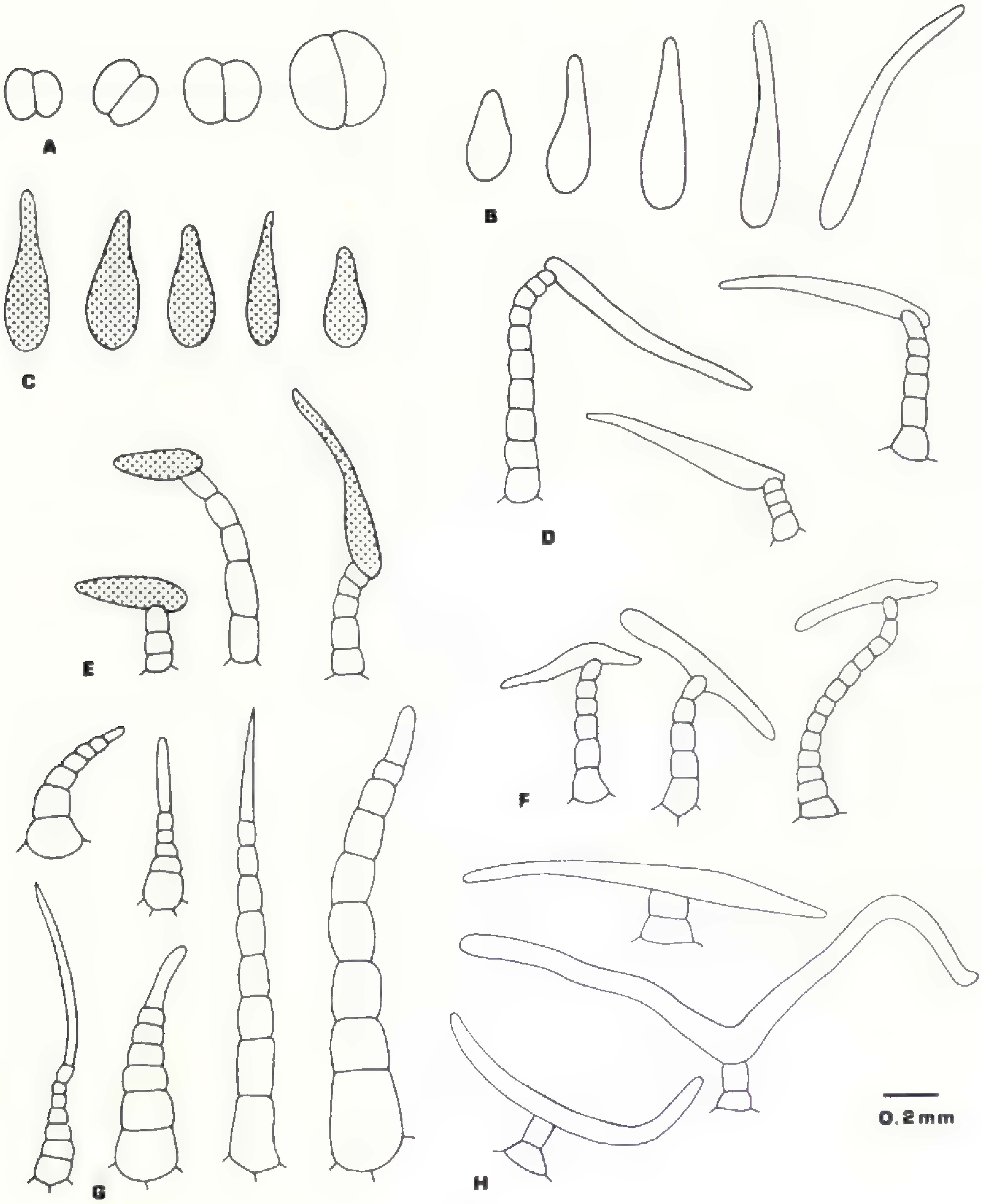


Figure 2. Line drawings of populations of the trichome types of *Vernonia:* (A) bilobed, (B) awl-shaped, (C) awl-shaped glandular, (D) L-shaped, (E) L-shaped glandular, (F) T-shaped, (G) uniseriate, (H) longhorn. Trichomes selected include typical and extreme forms.

they usually are the most reliable guide to relationships (Cowan, 1950):

Paired affinity index =

$$\frac{\text{trichome types common to both species}}{\text{total trichome types of both species}} \times 100.$$

RESULTS AND DISCUSSION

The trichome complements of 21 taxa of *Vernonia* are presented in Table 1 along with their distributions on the leaves. Photomicrographs and scanning electron micrographs of selected trichomes are shown in Figure 1. Populations of the trichome types are illustrated by camera lucida drawings in Figure 2. Comparison of possible arrangements of the taxa, based upon trichome complements with those groupings suggested by Gleason (1906, 1922, 1923) indicated that trichomes in *Vernonia* may indeed have some phyletic significance. Analysis of the trichome complement on both the upper and lower leaf surfaces suggested that certain species or groups of species stand apart from the other species (see Table 1). For example, *V. larsenii* and *V. lindheimeri* are closely related based upon gross morphology as well as upon trichome complement (King, 1971). They are the only taxa with the longhorn trichome type. *Vernonia larsenii* and *V. lindheimeri* also possess the same 15 flavonoid compounds and the same major sesquiterpene lactone, Glaucolide-F (Abdel-Baset and Padolina, per. com.). *Vernonia flaccidifolia* is the only species which does not have the bilobed trichome type. The taxon contains only one flavonoid compound and no sesquiterpene lactones (Abdel-Baset and Padolina, per. com.). Therefore, as Gleason (1923) suggested, *V. flaccidifolia* may be more advanced and evolutionarily specialized than some of the other species of *Vernonia*. *Vernonia fasciculata* and *V. marginata*, placed in the Fasciculatae group by Gleason (1923), possess the same types of trichomes on both the upper and lower surfaces of leaves (Jones, 1972). Chemical evidence indicates a close relationship; *V. marginata* and *V. fasciculata* have identical flavonoid com-

TABLE 2. Paired affinity indexes of the trichome complement of the lower epidermis for 21 closely related *Vernonia* taxa.

Taxon	V. schaffneri	V. greggii	V. ervendbergii	V. texana	V. arkansana	V. angustifolia	V. pulchella	V. glauca	V. larsenii	V. lindheimeri	V. flaccidifolia	V. lettermannii	V. noveboracensis	V. blodgettii	V. acaulis	V. gigantea	V. bald. ssp. bald.	V. bald. ssp. int.	V. missurica	V. fasciculata
V. greggii	100																			
V. ervendbergii	50	50																		
V. texana	50	50	50																	
V. arkansana	100	50	50	50																
V. angustifolia	100	100	50	50	100															
V. pulchella	75	75	75	75	75	75														
V. glauca	100	100	50	50	100	100	75													
V. larsenii	50	50	20	50	50	50	40	50												
V. lindheimeri	50	50	20	50	50	50	40	50	100											
V. flaccidifolia	20	20	20	0	20	20	16	20	0	0										
V. lettermannii	66	66	25	66	66	66	50	66	66	66	0									
V. noveboracensis	75	75	40	40	75	75	60	75	40	40	40	50								
V. blodgettii	50	50	40	50	50	50	40	50	50	50	20	66	75							
V. acaulis	50	50	100	50	50	50	75	50	20	20	20	25	40	20						
V. gigantea	75	75	40	40	75	75	60	75	40	40	40	50	100	75	40					
V. bald. ssp. bald.	60	60	33	33	60	60	50	60	33	33	33	40	50	33	33	50				
V. bald. ssp. int.	60	60	60	60	60	60	80	60	33	33	14	40	50	33	60	50	66			
V. missurica	50	50	20	50	50	50	40	50	50	50	40	66	75	100	20	75	33	33		
V. fasciculata	100	100	50	50	100	100	75	100	50	50	20	66	75	50	50	75	60	60	50	
V. marginata	100	100	50	50	100	100	75	100	50	50	20	66	75	50	50	75	60	60	50	10

pounds (Abdel-Baset and Padolina, per. com.). Also, these two species along with *V. arkansana* contain Glaucolide-M as the major sesquiterpene lactone compound.

Examination of the paired affinity indexes of the trichome complement of the lower leaf surfaces (Table 2) indicate several natural groupings. *Vernonia schaffneri, V. greggii, V. arkansana, V. angustifolia, V. fasciculata,* and *V. marginata* each have a paired affinity index of 100 to each other. Two of these species, *V. schaffneri* and *V. greggii* of Mexico, were considered by Gleason (1923) to be from the most primitive stock based upon morphology and phytogeography. *Vernonia schaffneri, V. greggii, V. ervendbergii,* and *V. texana* contain the same major sesquiterpene lactone, Glaucolide-A, and many identical flavonoid compounds (Abdel-Baset and Padolina, per. com.). *Vernonia gigantea* and *V. noveboracensis* have a paired affinity index of 100. They also possess the same flavonoid compounds and the same major sesquiterpene lactone compound, Glaucolide-A (Abdel-Baset and Padolina, per. com.). Gleason suggested that these two taxa evolved from the same ancestral line. The two species are similar in vegetative features such as leaf size and shape and stem height. *Vernonia noveboracensis* is a plant of wet soil, whereas *V. gigantea* grows in well drained soil. There are also differences in the number of flowers per head and in the length of the bract tips. On the other hand, it is difficult to distinguish vegetatively *V. gigantea* and *V. noveboracensis* grown in the greenhouse or the transplant garden unless the flowers are present.

Gleason (1923) proposed that the ancestral home of the genus *Vernonia,* as far as North American species are concerned, is tropical South America. He suggested that migration occurred from tropical South America through Central America and Mexico into Texas. From Texas migration accompanied by evolution proceeded in two directions, northward through the prairie region and eastward along the coastal plain. Speculation concerning the evolution of the taxa utilizing morphological and ecological

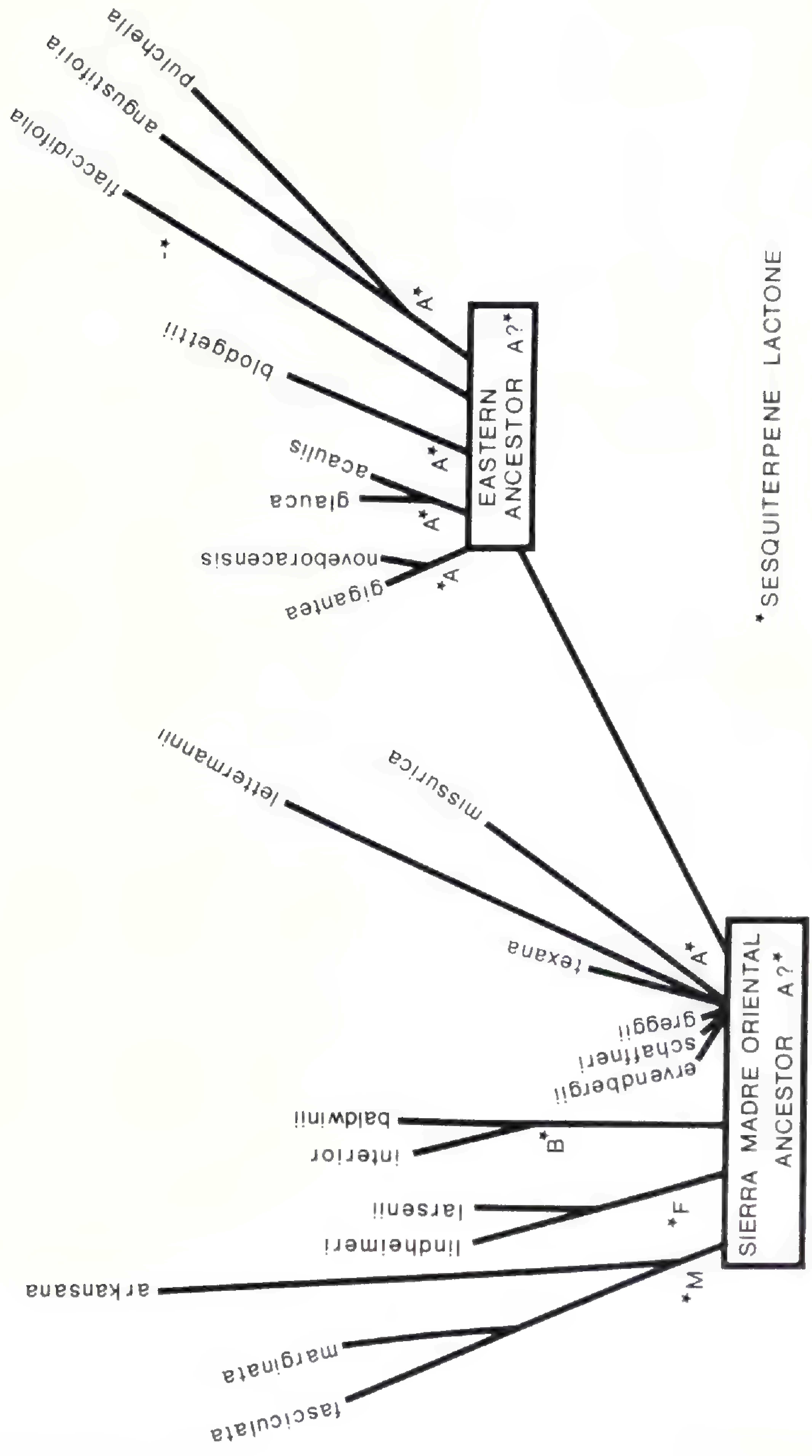


Figure 3. Diagrammatic scheme of migration and evolution of 21 taxa of *Vernonia*. Lines show distribution of the taxa by their location.

information and chemical data (Abdel-Baset and Padolina, per. com.) is presented in Figure 3. The western species of *Vernonia* have more flavonoids than do the eastern species of *Vernonia.* Generally, the western taxa contain from three to five compounds that are lacking in the eastern taxa. The eastern species have the same major sesquiterpene lactone, Glaucolide-A, that occurs in the species of *Vernonia* from the Sierra Madre Oriental of Mexico.

The use of the trichome complement as an aid to establishing relationships in *Vernonia* does have its limitations. For example, *V. blodgettii* and *V. missurica* have a paired affinity index of 100. Yet based upon morphological characters and geographic criteria they are very different. *Vernonia blodgettii* is a low, sparsely pubescent plant endemic to southern Florida, whereas *V. missurica* is a tall, extremely pubescent, wide-ranging species of the Mississippi Valley region. Another problem is presented by *V. baldwinii* ssp. *baldwinii* and ssp. *interior.* Evidence from morphological studies suggests close relationships (Faust, 1972). Populations of *V. baldwinii* ssp. *baldwinii* are found throughout the Ozark Plateaus province and the Ouachita province. *Vernonia baldwinii* ssp. *interior* populations occur primarily on the prairies and pastures of the central plains. The ranges of these two taxa overlap along the edges of the Ozarks and Ouachitas and a broad transition zone, or zone of intergradation is present (Faust, 1972). The characteristics of the intergradation zone surrounding the Interior Highlands suggest that the genomes of *V. baldwinii* ssp. *baldwinii* and ssp. *interior* are highly compatible and that the volume of gene flow between the two taxa may be relatively high. Additional evidence from biochemical systematics (Abdel-Baset and Padolina, per. com.) indicates a close relationship; the two subspecies contain the same major sesquiterpene lactone, Glaucolide-B. However, the trichome complement shows differences in the two subspecies. *Vernonia baldwinii* ssp. *baldwinii* has the L-shaped glandular trichome, whereas ssp. *interior* does not have this type. Also, uniseriate trichomes were

not found on the lower leaf surfaces of *V. baldwinii* ssp. *baldwinii.*

The evidence from this study suggests that trichomes can be diagnostic characteristics in *Vernonia.* However, their value as taxonomic criteria will be greatly increased if the information can be interpreted with reference to other lines of evidence such as that obtained from biochemical systematics, distributional studies, gross morphology, and hybridization experiments. All of the 21 taxa in this study form fully fertile F_1 hybrids but sometimes have hybrid breakdown in the F_2 and F_3 generations (Urbatsch, 1972; Faust, 1972; King, 1971; Jones, unpublished). Thus, trichome complement differentiation in this group of closely related plants must in some way be related to natural selection and the habitat that they occupy.

ACKNOWLEDGMENTS

This study was supported by the University of Georgia and by N.S.F. grant GB-20687. We thank Dr. W. J. Humphreys for the use of the facilities of the University of Georgia Electron Microscope Laboratory. We are grateful to Dr. Tom Mabry of the University of Texas and two of his students, Mrs. Zeinab Abdel-Baset and Mr. Bill Padolina, for the use of some unpublished biochemical data. Dr. Lowell Urbatsch, Mr. Bruce King, and Mr. Caywood Chapman have also worked with us on our studies in *Vernonia.*

LITERATURE CITED

CARLQUIST, S. 1961. Comparative plant anatomy. Holt, Rinehart, and Winston, New York. 29-36.

COWAN, J. M. 1950. The *Rhododendron* leaf: a study of epidermal appendages. Oxford and Boyd, London.

FAUST, W. Z. 1972. A biosystematic study of The Interiores species group of *Vernonia* (Compositae). Brittonia **24:** 363-378.

GLEASON, H. A. 1906. A revision of the North American Vernonieae. Bull. N. Y. Botan. Gard. **4:** 144-243.

————. 1922. Vernonieae. North American Flora **33:** 52-95.

——————. 1923. Evolution and geographical distribution of the genus *Vernonia* in North America. Amer. J. Bot. **10**: 187-202.

GOODSPEED, T. H. 1954. The genus *Nicotiana*. Chronica Botanica. Waltham, Mass. 109-131.

HEINTZELMAN, C. E., JR., and R. A. HOWARD. 1948. The comparative morphology of the Icacinaceae. V. The pubescence and crystals. Amer. J. Bot. **35**: 42-52.

HUNTER, G. E., and D. F. AUSTIN. 1967. Evidence from trichome morphology of interspecific hybridization in *Vernonia* (Compositae. Brittonia **19**: 38-41.

JONES, S. B. 1972. A systematic study of the Fasciculatae group of *Vernonia* (Compositae). Brittonia **24**: 28-45.

KING, B. L. 1971. The systematics of the *Vernonia lindheimeri* complex. M. S. Thesis. Univ. Georgia, Athens.

SOLEREDER, H. 1908. Systematic anatomy of the Dicotyledons. Vols. I & II (with addenda). Transl. by L. A. Boodle and F. E. Fritsch. Clarendon Press, Oxford.

URBATSCH, L. E. 1972. Systematic study of the Altissimae and Giganteae species groups of the genus *Vernonia* (Compositae). Brittonia **24**: 229-238.

DEPT. OF BIOLOGY
COLUMBUS COLLEGE
COLUMBUS, GEORGIA 31907
and
DEPT. OF BOTANY
UNIVERSITY OF GEORGIA
ATHENS, GEORGIA 30601

THE MORPHOLOGY AND SYSTEMATICS OF THE AUDOUINELLA COMPLEX (ACROCHAETIACEAE, RHODOPHYTA) IN NORTHEASTERN UNITED STATES

WM. J. WOELKERLING

Our knowledge of the marine species of the *Audouinella* complex along the New England and adjacent coasts of North America (including New York and New Jersey) comes mainly from the papers of Collins (1906, 1908, 1911), Davis (1913), Farlow (1881), Harvey (1853), Hehre and Mathieson (1970), Jao (1936), and Woelkerling (1972). Although many of the earlier records (which leave a number of points to be clarified) are incorporated in the descriptive catalogues of Taylor (1937, 1957), a comprehensive morphotaxonomic study of New England marine audouinelloid algae has not appeared to date, and the only monographic attempt involving the New England species has been that of Collins (1906) which included all of North America and is now out of date.

The present account reviews the systematics, morphology, ecology, and distribution of New England marine audouinelloid algae and provides a taxonomic treatment of all representatives based on extensive field and herbarium studies including the examination of many of the type collections. Canadian representatives of the complex (see South and Cardinal, 1970) have not been considered in detail because of inadequate material and the questionable nature of a number of records. A brief discussion on these taxa appears at the end of this report.

The techniques employed in these studies have been detailed elsewhere (Woelkerling 1970, 1973). Abbreviations for herbaria follow Lanjouw and Stafleu (1964); collections designated by WJW refer to specimens in the author's personal herbarium, currently housed at WIS.

A comprehensive review of the taxonomic history of audouinelloid algae has appeared recently (Woelkerling

1971), and the systematic conclusions reached in that paper are supported and adopted here. D'Lacoste and Ganesan (1972), however, maintain a classification of genera based on chromoplast morphology and criticize the placement of *Rhodochorton* in synonymy with *Audouinella* on grounds that Woelkerling (op. cit.) did not examine chromoplasts in living material of *Rhodochorton purpureum*, the type species of *Rhodochorton*. Cells of living *R. purpureum* (referred here to *Audouinella*) have been examined during the present New England study and found to show the same variation in chromoplast morphology described by Drew (1928, pp. 156, 177, fig. 33).

D'LaCoste and Ganesan (1972, p. 235) also point out (citing the findings of West, 1968, p. 98) that chromoplast shape can change as a result of fixation of material and that studies on the latter (including, presumably, those of Drew, 1928) can yield misleadng results. They apparently overlooked the other comments of West (op. cit.) in the same paragraph where he indicates the ". . . . inadequacy of plastid form as a taxonomic criterion in certain instances . . .". Thus the studies of West (1968), Woelkerling (1971), and others (see Woelkerling op. cit., p. 14) clearly show that chromoplast morphology is so variable in certain taxa that any generic segregation based on differences in plastid shape would result in a situation where certain species could be placed in several genera simultaneously. As a result, the present author has abandoned the use of chromoplast morphology as a generic criterion and has referred the genus *Rhodochorton* to the synonymy of *Audouinella*. For further comments, see the discussion of *A. purpurea* below and Woelkerling 1971, p. 4.

Taylor (1937, 1957) records 27 species in 5 genera from the northeastern coast of North America, all belonging to the family Acrochaetiaceae. (G. F. Papenfuss [personal communication] and P. C. Silva [personal communication] have indicated that the family name Acrochaetiaceae can be used correctly for the *Audouinella* complex even though the genus *Acrochaetium* is considered congeneric with

Audouinella; therefore the family name Audouinellaceae [Woelkerling 1971, p. 7, 22] is superfluous.)

Taylor's list may be enlarged to include the New England records of Giard (1890) and Hehre and Mathieson (1970) and the Canadian reports summarized by South and Cardinal (1970) to yield a total of 36 taxa for the region, apparently a greater number than in any other family of Rhodophyta. Of these, 29 are reported to occur in New England waters.

This account, however, recognizes only 11 species of audouinelloid algae as definitely occurring in New England; 7 of these are referred to the genus *Audouinella* and 4 to the genus *Colaconema.* Moreover, the names and(or) taxonomic status of all 29 taxa previously reported from New England have been changed; a summary appears in Table 1.

MORPHOTAXONOMIC FEATURES

The Acrochaetiaceae is generally circumscribed to include those Florideophycidae with simple or branched monosiphonous filaments usually less than 5 (rarely to 25) mm tall, with asexual reproduction by monospores, bispores, tetraspores, and/or multipartite spores, with carpogonia sessile on cells of vegetative filaments, intercalary in vegetative filaments or terminating one to several celled stalks, with gonimoblasts, when present, forming directly from the fertilized carpogonium, and without a pericarp. *Audouinella* Bory is the type genus.

Following Woelkerling (1971), the presence (*Audouinella*) or absence (*Colaconema*) of sexual reproduction is considered to provide a useful separation of the New England taxa into genera, with *Colaconema* regarded as a form genus similar to those of the Fungi Imperfecti. Taxa referrable to *Kylinia* Rosenvinge (in its *original* sense) and *Liagorophila* apparently do not occur in New England, and the systematic status of these genera remains in doubt (see Woelkerling 1971, p. 6).

Within the genera *Audouinella* and *Colaconema*, species have been grouped into three sections based on the absence of, the presence of one, or the presence of more than one pyrenoid per chromoplast. Species possessing more than one pyrenoid per chromoplast have not been collected in New England waters to date.

Additional features which appear to be of value in defining species limits include cell and spore dimensions, and in some cases chromoplast morphology, prostrate system morphology, and spore arrangement. Certain other characteristics (e.g. height of erect filaments, degree of branching, habitat preferences) sometimes are useful features for purposes of taxon recognition and in keys, but are too variable to be of value in defining species limits.

Considerable confusion has hitherto surrounded the identification of species in New England waters, and a number of records based on incorrect determinations have crept into and subsequently have been perpetuated in the literature. Thus, for example, collections originally identified by Collins (1906, 1911) as *Acrochaetium* (= *Chantransia*) *flexuosum* Vickers and subsequently recorded by Taylor (1937, 1957) have been re-examined during this study and found to belong unmistakably to *Colaconema secundata*. Likewise collections hitherto referred to *Acrochaetium sagraeanum* involve at least three different audouinelloid taxa, and the type specimen itself is here excluded from the Rhodophyta (see "Species Excludendae").

To help minimize confusion of a similar nature in the future, the distinguishing features of each taxon known to occur in New England waters have been outlined at the onset of the discussion section of each species in the taxonomic accounts. Available distributional and ecological data are also included. While each species recognized here possesses a distinctive set of morphological features, most taxa exhibit considerable variation, and numerous plants of a collection should, therefore, be examined to build a composite picture of the population before identification is attempted. Collections of single specimens whose status is in doubt are best left unidentified.

KEY TO SPECIES OF NEW ENGLAND AUDOUINELLOID ALGAE

This key includes only species definitely known to occur in New England waters. Records of questionable occurrence, of taxa whose systematic status is uncertain, etc. are discussed in a separate section at the end of this report. Characters relating to chromoplasts and pyrenoids often are not preserved in dried or spirit material, and in these cases supplementary criteria are given in the key.

1. Multicellular prostrate system present; filamentous, parenchymatous, or pseudoparenchymatous. ...... 2.
1. Multicellular prostrate system absent; plants attached to substrate by a single cell which may rarely give rise to one or several accessory cells. .... 7.
   2. Cells with a single chromoplast containing a single pyrenoid; plants generally (but not invariably) epiphytic or endophytic. .... 3.
   2. Cells with one to a number of chromoplasts without pyrenoids; plants generally (but not invariably) saxicolous or endozoic. .. .. 10.
3. Erect filaments generally over 500 μm long and usually exceeding the prostrate filaments in length; monosporangia commonly over 15 μm long. .... 4.
3. Erect filaments generally under 250 μm long or absent, usually shorter than or equal to the prostrate filaments; monosporangia under 15 μm long. .... 11.
   4. Chromoplasts distinctly stellate; prostrate system developing from an orbicular, parenchymatous group of cells which forms a small disc that may later proliferate and become obscured; lateral branches commonly but not always virgate or secundate. .... 11. *Colaconema secundata.*
   4. Chromoplasts parietal lobate curved plates; prostrate system filamentous or pseudoparenchymatous, not developing from a distinctive parenchymatous disc; lateral branches not virgate. . 5.
5. Monosporangia borne, at least in part, in clusters of 3 or more on branched stalks. 4. *Audouinella daviesii.*

5. Monosporangia borne singly or in pairs but not in clusters. . . . . 6.
   6. Prostrate system composed of an enlarged, central, more or less panduriform to pyriform cell and accessory cells or filaments which arise from it. . . . . 3. *Audouinella dasyae.*
   6. Prostrate system filamentous or pseudoparenchymatous, without an enlarged, central panduriform or pyriform cell. . . . . 6. *Audouinella saviana.*
7. Cells commonly over 20 μm long; plants commonly over 500 μm tall. . . . . 8.
7. Cells under 20 μm long; plants rarely over 100 μm tall. . . . . 9.
   8. Basal cell elongate, panduriform to pyriform; usually bearing accessory cells or filaments. . . . . 3. *Audouinella dasyae.*
   8. Basal cell globose or subglobose; lacking accessory cells or filaments. . . . . 2. *Audouinella alariae.*
9. Cells commonly over 10 μm long; filament(s) of erect system procumbent; protoplast of basal cell hemispherical and distinctly flattened on side in contact with substrate. . . . . 7. *Audouinella unifila.*
9. Cells generally 10 μm or less long; filament(s) of erect system upright to arcuate; protoplast of basal cell more or less globose. . . . . 5. *Audouinella microscopica.*
   10. Sporangia (i.e. carpotetrasporangia) borne mostly in clusters on branched stalk-like gonimoblast filaments; plants commonly but not invariably saxicolous. . . . . 1. *Audouinella purpurea.*
   10. Sporangia (i.e. tetrasporangia) solitary, sessile or on unbranched stalks; plants commonly but not invariably endozoic. . . . . 8. *Colaconema membranacea.*
11. Cells commonly over 2 diameters long; prostrate filaments widely creeping, commonly over 1 mm long. . . . . 10. *Colaconema minima.*
11. Cells rarely over 2 diameters long; prostrate filaments rarely over 500μm long. . . . . . . 9. *Colaconema humilis.*

AUDOUINELLA Bory

Audouinella Bory 1823: 340 (as *Auduinella*). Woelkerling 1971: 22. *Acrochaetium* Naegeli 1861: 402. *Balbiania* Sirodot 1876: 149. *Chromastrum* Papenfuss 1945: 320. *Grania* Kylin 1944: 26. *Rhodochorton* Naegeli 1861: 355. *Thamnidium* Thuret In Le Jolis 1863: 110. *Trentepohlia* Pringsheim 1862: 29.

Note: Species now referrable to *Audouinella* have also been placed in the past in *Byssus, Callithammion, Ceramium, Chantransia, Conferva, Kylinia*, and *Trentepohlia* Martius (1817). In addition, some species hitherto placed in *Acrochaetium, Audouinella, Callithamnion, Cermium, Chantransia, Chromastrum, Kylinia, Rhodochorton*, and *Trentepohlia* are referable here to the form genus *Colaconema*.

Plants epibiotic, endobiotic, or saxicolous; attached to or suspended in the substrate by a single basal cell, by a prostrate system of simple or branched filaments which may or may not become pseudoparenchymatous, or by a parenchymatous disc. Erect filaments simple or branched, up to 25 mm long; cells containing one to many variously shaped chromoplasts with or without pyrenoids.

Asexual reproduction by monosporangia, bisporangia, tetrasporangia, and/or multipartite sporangia; sporangia sessile or stalked and borne on erect or prostrate filaments.

Plants monoecious or dioecious. Spermatangia in clusters or occasionlly single or in pairs, terminal or lateral on simple or branched stalks or sessile on ordinary vegetative cells. Carpogonia intercalary or more commonly sessile or terminating 1-2 celled stalks on vegetative cells, solitary or rarely in groups of 2-3; remaining undivided or dividing transversely after fertilization and giving rise directly to gonimoblast filaments bearing carposporangia or carpotetrasporangia.

Type Species: Audouinella hermanni (Roth) Duby.

Section I

Species in this section are not known to contain pyre-

noids in their chromoplasts. Within each section species are discussed in alphabetical order by specific epithet. Cell and spore dimensions are based only on the New England populations studied and may not reflect the total range of variation found in populations elsewhere. The ratio of greatest cell length to greatest cell diameter (width) is denoted by L/D in all species accounts.

1. **Audouinella purpurea** (Lightfoot) comb. nov. Figs. 52-55.

Byssus purpurea Lightfoot 1777: 1000.

Callithamnion purpureum (Lightfoot) Harvey 1841: 116, 1849: 183.

Conferva purpurea (Lightfoot) Dillwyn 1806: 56, pl. 43. C. Agardh 1817: XXIX.

Rhodochorton purpureum (Lightfoot) Rosenvinge 1900: 75. Collins, Holden, and Setchell 1895: 49. Conway and Knaggs 1966: 195 et. seq., Figs. 1-3. DeToni 1903: 1510. Edelstein and McLachlan 1966a: 1041, 1052. Edelstein et al. 1970: 626. Hamel 1927: 57, 108; 1928: 201; 1928a: 151. Hehre and Mathieson 1970: 207. Knaggs 1965: 499 et seq., 1966b: 521 et seq., pl. 102-107; 1967: 139 et seq.; 1967a: 549 et seq., pl. 134-139; 1968: 449 et seq., pl. 170-174. Mathieson et al. 1969: 132. Papenfuss 1945: 327. South 1970: 1. South and Cardinal 1970: 2079. Stone et al. 1970: 325. Taylor 1957: 226, pl. 45, Figs. 1-2. West 1967: 11; 1969: 12 et seq., Figs. 1-22; 1970: 368 et seq., Figs. 1-8.

Trentepohlia purpurea (Lightfoot) C. Agardh 1824: 36. Harvey 1833: 382. Harvey and MacKay 1836: 218.

Rhodochorton islandicum Rosenvinge 1900: 75, Figs. 1-4. Papenfuss 1945: 327.

Rhodochorton intermedium (Kjellman) Kjellman 1883: 184, pl. 15, Fig 8. DeToni 1903: 1509. Hamel 1927: 107; 1928: 200.

Thamnidium intermedium Kjellman 1875: 28, Fig. 10.

Rhodochorton parasiticum Batters 1896: 389. Collins 1900: 51; 1900a: 12; 1911: 281. Collins, Holden and Setchell 1901: 848.

Callithamnion rothii (Turton) Lyngbye 1819: 129, pl. 41a. J. Agardh 1851: 17. Bailey 1847: 85. Collins 1880: 162. Eaton 1873: 348. Farlow 1875: 376; 1876: 704; 1879: 169; 1881: 121. Harvey 1846: pl. 120B; 1853: 243. Hay 1887: 66. Hay and MacKay 1888: 173. Jelliffe 1899: 15. Jordan 1874a: 488. Klugh 1917: 83. Kuetzing 1861: XI, pl. 621. Olney 1871: 8; 1872: 132. Pike 1886: 110.

Rhodochorton rothii (Turton) Naegeli 1861: 356, pl. 1, Figs. 1, 3. Bell and McFarlane 1933: 270. Boergesen 1902: 390, Figs. 61-64. Collins 1894: 230; 1900: 51; 1905: 234; 1911: 280; 1914:4. Davis 1913: 818. DeToni 1903: 1507. Drew 1928: 177. Gibson 1891: 201, Fig. 38. Hamel 1927: 54, 106, Fig. 38; 1928: 199; 1928a: 147, Fig. 38. Hylander 1928: 169. Kjellman 1883: 185. Kuckuck 1897: 345, Fig. 5. Kylin 1944: 28, Fig. 25. Nakamura 1941: 282, Figs. 8-9. Rosenvinge 1923-24: 390, Figs. 328-330. Taylor 1937: 239, pl. 45, Figs. 1-2. Whelden 1947: 119.

Thamnidium rothii (Turton) Thuret In LeJolis 1863: 111, pl. 5.

Rhodochorton tenue Kylin 1925: 44, Figs. 25 b-e. Drew 1928: 177, pl. 40, Fig. 33. Papenfuss 1945: 328. West 1969: 12 et seq., Figs. 1-22.

Conferva violacea Roth 1797: 190, pl. 4, Fig. 1. Non *Conferva violacea* Hudson 1778: 592, nec *Ceramium violaceum* Roth 1797: 150, nec *Conferva rothii* Turton 1806: 1809.

Plants saxicolous or occasionally epibiotic, caespitose or forming conspicuous matted expanses with erect filaments up to 25 mm tall; original spore non-persistent. Prostrate system composed of branched, creeping filaments which may be loosely entangled or more compactly pseudoparenchymatous, but not forming distinct discoid holdfasts. Erect filaments moderately to freely and irregularly branched and usually tapering towards the tips. Cells cylindrical, 10-20 μm wide and 15-75 μm long, L/D (1-)2.5; tapering to 7-12 μm wide and 40-175 μm long (L/D up to 15) near and at the tips of branches; each cell containing

one to a number of irregularly lobate to reticulate to discoid chromoplasts without pyrenoids.

Monosporangia, bisporangia, parasporangia, and sex organs not observed. Carposporphytes consisting of short (up to 10 cells long), simple or usually branched gonimoblast filaments bearing terminal or occasionally lateral, ovoid, solitary or paired carpotetrasporangia 15-25 μm wide and 25-40 μm long. Other reproductive structures not observed.

Type Locality: Ruined Abbey, Island of Iona, Scotland.

Type: Possibly destroyed (see Conway and Knaggs 1966).

Distribution: Nearly cosmopolitan in temperate and polar marine waters; also known from terrestrial and freshwater sites.

Hosts: Most common on rocks but also on algae and invertebrates.

Specimens examined:

CONNECTICUT: Bridgeport (Harbor) 4. IX. 1893, *Johnson* (NY); 8. III. 1891, *Holden* (NY).

MAINE: Appledore Island (Isles of Shoals), 28. VII. 1938, *Croasdale* (NHA). Haley's Cove (Smuttynose Is., Isles of Shoals), 16. VI. 1966, *Shipman* (NHA). Harpswell, 6. VII. 1905, *Collins* (NY). Inner Mark Island, 29. VIII. 1903, *Collins* (NY). Lubec (Bailey's Mistake) 22 V. 1966, *Femino* (NHA). Lubec (West Quoddy Head), 21. V. 1966, *Ball* and *Lavise* (NHA). Peaks Island, VII. 1881, *Collins* (NY); 22. V. 1904, *Collins* (NY). Penobscot Bay, prior to 1853, *Hooper* (TCD). Popham, 7. VIII. 1900, *Cherrington* (NY). South Harpswell, 17. VII. 1902, Collins (NY); 8. VII. 1903, *Collins* (NY). York (Nubble Light), 19. V. 1966, *Pollock* (NHA).

MASSACHUSETTS: Magnolia, 24. VI. 1896, *Collins* (NY). Nahant, 18. IV. 1879, *Collins* (?) (NY); 9. VI. 1889, *Collins* (NY); 30. III. 1890. *Collins*, (NY); 22. II. 1891, *Collins* (NY, = Collins, Holden, and Setchell 1895, No. 49); 30. V. 1900, *Collins* (NY, = Collins, Holden, and Setchell 1901, No. 848); 13. IV. 1907, Collins (NY). Penikese Island, 9. VII. 1926, *Taylor* (NY). Sandwich (jetty), 7. IV. 1968, *Kastelowitz* (NHA); 22. I. 1971, *Woelkerling* (WJW 3297). Scusset Beach, 7. IV. 1968, *Bosworth* (NHA); 29. III. 1969, *Mills* (NHA).

NEW HAMPSHIRE: Hampton, VIII. 1884, *Collins* (NY). North Wallis Sands, 16. VII. 1967, *Hehre* (NHA). Rye Ledge, 18. VIII. 1966, *Conway* and *Shipman* (NHA); 15. X. 1966, *Hehre* (NHA); 23. XII. 1966,

Conway and *Hehre* (NHA); 10. I. 1967, *Conway* and *Hehre* (NHA); 26. II. 1967, *Conway* and *Hehre* (NHA); 25. IV. 1967, *Hehre* (NHA); 25. V. 1967, *Hehre* (NHA); 22. VI. 1967, *Hehre* (NHA); 24. VII. 1967, *Hehre* (NHA); 12. VIII. 1967, *Mathieson* (NHA), 15. III. 1969, *Hutchinson* (NHA).
NEW JERSEY: Bay Ridge, 17. III. 1893, *Collins* (NY).
NEW YORK: Fort Hamilton (Long Island), 16. V. 1866, *Pike* (NY).
RHODE ISLAND: Newport, prior to 1853, *Bailey* (TCD).

Audouinella purpurea is distinguished from other New England audouinelloid algae in having a diphasic life cycle involving the production of carpotetraspores (Fig. 52) and in having erect filaments commonly over 10 mm long with cells containing 1 to a number of irregularly shaped to discoid chromoplasts without pyrenoids (Figs. 53-55). It is the only known New England species of audouinelloid algae which commonly develops on rocks and forms mat-like expanses.

A. purpurea grows throughout the year in New England and has been collected as far south as New Jersey. Most commonly it occurs in shaded habitats in the midlittoral, especially underneath *Ascophyllum* or *Fucus*, but it has been found throughout the intertidal and in the sublittoral zones. In sublittoral communities it apparently grows primarily as an epiphyte on kelp stipes. This species is widely distributed throughout the cooler regions of the northern hemisphere, and because it sometimes becomes an ecological dominant in the intertidal zone, it has been reported more frequently from northern regions than any other audouinelloid species.

Its vegetative morphology can vary considerably, depending upon the particular ecological niche it occupies, and this morphological variation has been the subject of intensive studies (Conway and Knaggs 1966; Knaggs 1965, 1966, 1966a, 1967, 1967a, 1968). In general, plants growing under stressed conditions tend to have shorter and less branched erect filaments. Knaggs (1965, 1966, 1966a) and Conway and Knaggs (1966) have recorded this species from freshwater and terrestrial habitats as well as intertidal and sublittoral habitats and have

recognized a number of distinct taxonomic forms. These forms, however, appear to have little taxonomic value in so far as New England populations are concerned and consequently are not recognized here as distinct systematic entities.

Reproductive structures have been found only in the winter and early spring; sterile plants, however, occur throughout the year. The latter bear some superficial resemblance to *Spermothamnion* but can easily be distinguished from that genus by the possession of a true heterotrichous habit. Sex organs have not been found in New England populations and to the author's knowledge have never been found in field collected samples. West (1969, 1970) has given an excellent account of these and other stages in the life history based on culture studies; Knaggs (1968) also reported sexual stages in cultural material. Mature carposporphytes are somewhat more loosely organized in comparison with other New England species and often greatly resemble ordinary vegetative branches bearing sporangia. Only carpotetrasporangia have been seen during this study, but bisporangia and parasporangia are reported from elsewhere (Conway and Knaggs, 1966; Knaggs, 1967).

Audouinella purpurea was the first described member of the *Audouinella* complex (Lightfoot, 1777), and because of its distinctiveness as a species (primarily in terms of habit and chromoplast morphology), it traditionally has been referred (as the type species) to a separate genus — *Rhodochorton* Naegeli (1861, p. 355). While recognizing its distinctness *as a species*, no reliable characteristics of generic significance (see Woelkerling 1971, p. 4) are apparent at present; consequently *Rhodochorton* is considered congeneric with *Audouinella*, and the type species, *R. purpureum*, is also referred to *Audouinella*.

Following Papenfuss (1945) and West (1969), the taxa originally described as *Rhodochorton parasticum* Batters (1869), *R. rothii* (Turton) Naegeli (1861), *R. tenue* Kylin (1925), and *Thamnidium intermedium* Kjellman (1875)

are here considered conspecific with *Audouinella purpurea*. In agreement with Conway and Knaggs (1966), *Rhodochorton islandicum* Rosenvinge is also regarded as conspecific with *Audouinella purpurea*.

Section II

Species in this section have chromoplasts with only one pyrenoid each.

2. **Audouinella alariae** (Jonsson) comb. nov. Figs. 1-9.

Acrochaetium alariae (Jonsson) Bornet 1904: XIX. Collins 1906: 192. Croasdale 1941: 214. Erskine 1955: 151. Hamel 1927: 84; 1928: 177. South 1970: 1. South and Cardinal 1970: 2079. Taylor 1937: 229.

Chantransia alariae Jonsson 1901: 132, Fig. 1. Adams 1904: 351. Boergesen 1902: 356. Boergesen and Jonsson 1905: Appendix, p. III. Collins 1911: 276. Cotton 1912: 98, 133. DeToni 1924: 45. Levring 1937: 86, Fig. 12.

Chromastrum alariae (Jonsson) Papenfuss 1945: 320.

Kylinia alariae (Johnsson) Kylin 1944: 13. Hehre and Mathieson 1970: 206. Mathieson et al. 1969: 132. Papenfuss 1947: 436. Taylor 1957: 213.

Acrochaetium rhipidandra (Rosenvinge) Hamel 1927: 25, 82, Fig. 23; 1928: 176; 1928a: 119, Fig. 23.

Chantransia rhipidandra Rosenvinge 1909: 91, Figs. 19-20. DeToni 1924: 37. Kylin 1928: 5, Figs. 1-2. Levring 1937: 83.

Chromastrum rhipidandra (Rosenvinge) Papenfuss 1945: 322.

Kylinia rhipidandra (Rosenvinge) Kylin 1944: 13. Papenfuss 1947: 437.

Rhodochorton rhipidandra (Rosenvinge) Drew 1928: 151.

Chantransia secundata auct. non. (Lyngbye) Thuret: Collins, Holden, and Setchell 1896a: 236. Collins 1900: 49 (pro parte).

Chantransia virgatula auct. non. (Harvey) Thuret: Collins 1894: 233 (Holden collection).

Plants epiphytic, up to 1.0 mm tall; original spore persisting as a globose to subglobose unicellular base up to 25 μm in diameter and usually larger than other cells. Basal cell bearing 1-2 (-3) erect filaments which are almost always branched; laterals irregularly arranged, few in number and nearly simple to numerous and frequently further subdivided; laterals generally tapering towards the tips. Cells cylindrical or occasionally somewhat barrel-shaped near the base, 12-18 μm wide and 15-60 μm long near the base, L/D (1-) 1.5-4; (4-) 7-10 (-15) μm wide and 15-65 μm long in the laterals, L/D 2-6 (-9); tapering to 4-9 μm wide near the tips; each cell containing a single chromoplast and one pyrenoid. Unicellular hairs not observed.

Monosporangia ovoid, 8-12 μm wide and 12-20 μm long, solitary or in pairs (occasionally in groups of 3), sessile or stalked, scattered to secundate along lateral branches or occasionally opposite or terminal on the branchlets.

Other reproductive structures not observed in New England collections.

Type Locality: The Maelstrom, Hvammsfjördur, Iceland.

Type: c (Jonsson 597).

Distribution: Northern Massachusetts northward; Denmark, Faeroes Islands, France, Great Britain, Iceland, Norway.

Hosts: Alaria in New England; *Alaria* and *Porphyra* in Europe.

Specimens examined:

MAINE: Bald Head Cliffs (Ogunquit), 17. VIII. 1966, *Shipman* and *Conway* (NHA); 7. XI. 1967, *Stone* and *Hehre* (NHA). Boon Island, 26. VII. 1938, *Croasdale* (NHA). Burnt Island (Cushing), 17. VII. 1888, *Collins* (NY). Cushing, no date, *Collins* (NY, Collins 446A). Casco Bay, VII. 1939, *Weatherhill* (FH). Hardhead Island (Penobscot Bay), VII. 1894, *Collins* (NY, loose duplicate of P.B.A. No. 236; FH, P.B.A. No. 236; WIS, P.B.A. No. 236). Mt. Desert Island, 12. VIII. 1890, *Holden* (NY, Holden 134). Nubble Light, 19. VIII. 1969, *Hehre* (WJW 2275). Pemaquid Point, 18. VII. 1901, *Collins* (NY). South Harpswell, 8. VII. 1903, *Collins* (NY).

MASSACHUSETTS: Pigeon Cove (Cape Ann), 25. IX. 1966, *Hehre* (NHA).
NEW HAMPSHIRE: Hampton, VII. 1894, *Collins* (NY); VIII. 1894, *Collins* (NY). Star Island (Isles of Shoals), 22. VII. 1966, *Conway* and *Shipman* (NHA).
CANADA: Ferryland, Avalon Penn., Newfoundland, 4. XII. 1968, *South* (CANA 7583). Ketch Harbor, Nova Scotia, 7. II. 1966, *Edelstein* (?) (Edelstein 2239, Herb. Nat. Res. Council, Halifax). Mulholland's Bend, Campebello Island, New Brunswick, 15. VI. 1967, *Hehre* and *Stone* (NHA).
DENMARK: Frederikshavn, Kattegat, 25. VIII. 1891, *Rosenvinge* (C, type of *Chantransia rhipidandra*).
ICELAND: The Maelstrom, Hvammsfjördur, 28. VI. 1897, *Jonsson* (C, Jonsson 597, type of *Audouinella alariae*).

Audouinella alariae is distinguished from other New England audouinelloid algae by the presence of a unicellular, more or less globose base (Figs. 1-3) bearing erect filaments whose cells are commonly over 2 diameters and 20 μm long. It has been collected in New England from July through November on *Alaria esculenta* (L.) Greville, but also has been collected along the Canadian coast in February, June, and December. Further investigation may show that *Audouinella alariae* not only develops at other times of the year, but also grows on other substrates.

New England populations of *A. alariae* exhibit considerable morphological variation. Some mature plants reach heights of 1 mm while others never exceed 500 μm. A few plants consisting of a single, nearly simple erect filament have been observed (Fig. 7), but in most cases lateral branches develop. The laterals themselves may be little further branched, long, and bear a few, scattered sporangia (Figs. 8-9), or they may be more densely subdivided, relatively short, and bear numerous, rather crowded sporangia (Figs. 4-5). All intermediate situations can occur within a single population.

Although pyrenoids have been observed during this investigation, the chromoplast shape could not be definitely determined. Jonsson (1901, p. 133) and Levring (1937, p. 87) both report a stellate chromoplast, but further study is needed to determine to what extent, if any, the plastid

shape might vary in this species. Collins (1906, p. 192) and Taylor (1937, p. 229; 1957, p. 213) report unicellular hairs, but such hairs have not been observed during this study and have not been recorded by other authors.

Collins (1906), Jonsson (1901), and Taylor (1937, 1957) report the monosporangia to be sessile and opposite; Adams (1904) records mostly alternate sporangia; and Levring (1937) states that the sporangia are often scattered. Plants in New England populations show a combination of all such arrangements on the same individual (Figs. 4, 5, 7-9), with oppositely arranged sporangia occurring only occasionally. They may be either sessile or on 1-2 celled stalks and sometimes terminate short lateral branches.

Critical comparisons (Table 2) of type collection material of *Audouinella alariae* and *Chantransia rhipidandra* Rosenvinge strongly indicate that the two taxa are conspecific. Rosenvinge (1909, p. 91) stated that *C. rhipidandra* differed from *Audouinella alariae* in ". . . having much thicker and more branched filaments, and further by the branches being often opposite . . ."; he also noted the presence of sex organs in the former and their absence in the latter.

However, plants examined during this study, including the types of both taxa, indicate considerable overlap in filament diameters (Table 2), and the degree of branching and branch arrangement (Figs. 4, 5, 7-9) vary considerably. Thus these criteria do not appear reliable for separating the two taxa. The presence or absence of sex organs alone also appears unreliable as a criterion of species separation (Woelkerling 1971), and since there appear to be no other criteria by which the two taxa can be reliably separated, they are regarded here as conspecific.

Hamel (1927, 1928), Kylin (1928), and Rosenvinge (1909) have described and illustrated sexual and carposporophyte stages of this species (all using the specific epithet "rhipidandra").

Chantransia unilateralis Kjellman (1906, p. 11, Taf. II, Figs. 1-4) is almost certainly conspecific with *Audouiunella*

alariae, but the type collection of Kjellman's species apparently is not at UPS (personal communication), and final judgement must, therefore, be deferred until the type can be located and examined.

The relationships of *A. alariae* to at least 15 other taxa of similiar morphology await clarification. Once critical examinations of all the types and other populations of these taxa are completed, it appears likely that a number will prove to be conspecific with *A. alariae*.

Specimens referred to *Chantransia secundata* by Collins (1900) and Collins et al. (1896a) and to *Chantransia virgatula* by Collins (1894) have been examined and found to contain only plants of *Audouinella alariae*. In the case of the former specimens, this confirms the opinions of Jonsson (1901) and Collins (1906).

Young plants of *Audouinella dasyae* bear many resemblances to *A. alariae* but usually can be recognized by the presence of a panduriform or pyriform basal cell rather than a globose one.

3. **Audouinella dasyae** (Collins) comb. nov. Figs. 10-31.

Acrochaetium dasyae Collins 1906: 191. Aziz 1967: 408. Davis 1913: 813. Edelstein et al. 1967: 195, Fig. 9. Hamel 1927: 77, 95, Figs. 47b-g; 1928: 171, 189, Figs. 47b-g. Papenfuss 1945: 308. Taylor 1937: 231; 1957: 217.

Chantransia dasyae (Collins) Collins 1911a: 186. DeToni 1924: 40.

Acrochaetium intermedium Jao 1936: 242, pl. 11, Figs. 1-4. Papenfuss 1945: 314. Taylor 1937: 231, pl. 33, Figs. 1-4; 1957: 218, pl. 33, Figs. 1-4.

Acrochaetium subseriatum Jao 1936: 243, pl. 11, Figs. 5-7 (Non *Acrochaetium subseriatum* Boergesen 1932: 118, Figs. 6-7). Taylor 1937: 232, pl. 33, Figs. 5-7.

Acrochaetium zosterae Papenfuss 1945: 307. Taylor 1957: 218, pl. 33, Figs. 5-7.

Callithamnion virgatulum auct non Harvey: Harvey 1853: 243.

Plants epiphytic, caespitose, up to 3 mm tall. Prostrate

system usually consisting of an enlarged, central, more or less panduriform to pyriform cell — the original spore — bearing several smaller accessory cells or short filaments; central cells becoming obscured by accessory filaments in robust plants or rarely remaining unicellular in young or small plants. Erect filament(s) arising from the central cell, moderately to freely and irregularly branched; sometimes tapering towards the tips. Cells cylindrical, 25-70 (-90) μm long and 7-12 (-16) μm wide [L/D 2-6 (-10)] in main axes, 15-60 μm long and 6-10 μm wide (L/D 2-7) in the laterals; each containing a single parietal chromoplast with one pyrenoid. Unicellular hairs not observed.

Monosporangia ovoid, 16-24 μm long and 9-12 (-16) μm wide, solitary or occasionally in pairs, sessile or occasionally stalked, in secundate series along the laterals or more scattered. Bisporangia and tetrasporangia not observed. Spermatangia globose to ovoid, up to 3μm wide and 5 μm long, borne terminally or laterally on vegetative cells or unicellular stalks, or usually in clusters of varying size on multicellular simple or branched stalks. Carpogonia sessile or stalked, scattered over the lateral filaments; fertilized carpogonium dividing transversely and eventually giving rise to a branched gonimoblast bearing terminal carposporangia 16-24 μm wide and 9-12 μm long.

Type locality: Woods Hole, Massachusetts.

Type: FH (accompanied by a card in Collins script and numbered 5370). Isotypes have been distributed as No. 1342 in Phycotheca Boreali Americana (Collins, et al. 1906).

Distribution: Atlantic Coast of North America.

Hosts: *Dasya* (Rhodophyta) and *Zostera* (Angiospermae).

Specimens examined:

MASSACHUSETTS: Edgartown (Martha's Vineyard), 19. XII. 1969, *Woelkerling* (WJW 2245). Great Rip (1.25 km E. of Great Point, Nantucket Is.), 14. IV. 1970, *Woelkerling* (WJW 2500). North Eastham, 9. VIII. 1959, *Lamb* (FH, filed under the host, *Dasya pedicel-*

lata). Old Silver Beach, 31. X. 1970, *Woelkerling* (WJW 2853); 15. XI. 1970, *Woelkerling* (WJW 2856); 30. XII. 1970, *Woelkerling* (WJW 2977). Waquoit Bay (Falmouth), 16. X. 1969, *Conway* (WJW 2293); 27. IV. 1970, *Woelkerling* (WJW 2534). West Falmouth Harbor, 6. I. 1970, *Woelkerling* (WJW 2284); 18. VII. 1970, *Woelkerling* (WJW 2751). West Yarmouth, 17. IX. 1969, *Woelkerling* (WJW 2252); 3. X. 1969, *Woelkerling* (WJW 1852), (WJW 2255); 16. XI. 1969, *Woelkerling* (WJW 2249), (WJW 2250); 12. XII. 1969, *Woelkerling* (WJW 2260). Woods Hole, 12. VIII. 1894, *Holden* (FH, filed under the host, *Dasya pedicellata*); 2. IX. 1905, *Collins* (FH, type); 29. VIII. 1944, *Taylor* (FH, filed under the host, *Dasya pedicellata*); 4. II. 1970, *Woelkerling* (WJW 2330); 5. VII. 1970, *Wilce* (WJW 2690); 17. VII. 1970, *Woelkerling* (WJW 2716); 13. X. 1970, *Woelkerling* (WJW 2820); 29. I. 1971, *Woelkerling* (WJW 3298); 16. II. 1971, *Woelkerling* (WJW 3311); 25. VIII. 1933, *Jao* (MICH, Woods Hole No. 278, type of *Acrochaetium zosterae* Papenfuss). Pine Island (Woods Hole), 7. VIII. 1934, *Jao* [MICH, Woods Hole No. 277, type of *Acrochaetium intermedium* Jao, non *Thamnidium intermedium* Kjellman = *Audouinella purpurea* (Lightf.) comb. nov.].

NEW JERSEY: *Great Bay* (.4 km SSW of Wells Is.), 17. VII. 1963, *Moeller* (RUT, filed under the host, *Dasya pedicellata*).

NEW YORK: Hell Gate (Long Island), 29. IX. 1850, *Walters* (TCD).

CANADA: Malpeque Bay (Prince Edward Island), 5. VIII. 1966, *Edelstein* (Nat. Res. Coun. Herb., Halifax).

Audouinella dasyae is distinguished from other New England audouinelloid algae by the presence of an enlarged, central, more or less panduriform to pyriform cell in the prostrate system (Figs. 12-17) which bears accessory prostrate cells or filaments and which gives rise to the erect filaments. *A. dasyae* appears to be confined to the sublittoral and has been collected in New England all months except March, May, and June. It undoubtedly occurs throughout the year. Sexual plants have been found from July through November; tetrasporangial plants have not been observed but probably occur and are to be expected in deeper waters in late spring and early summer.

Like many audouinelloid algae, *A. dasyae* exhibits considerable variation [more than indicated by Collins (1906) or Taylor (1957)] in cell width, height, spore size, and other features. On *Dasya* for example, it is not uncommon to find mature plants under 500 μm tall anchored to the monosiphonous filaments of the host and plants up to

3 mm attached to the more robust multilayered primary axes of the the host. Likewise branching of *A. dasyae* may be dense or relatively sparse (Figs. 20, 21), depending upon the "growing room" available. In all cases the enlarged central cell representing the original spore was panduriform or pyriform; globose cells described by Taylor (1957) and illustrated by Hamel (1927, Fig. 47b; 1928, Fig. 47b) have not been observed except in sporelings (Figs. 10-11). In addition, the range of cell and spore dimensions recorded during this study are considerably greater than those reported by Collins (1906) or Taylor (1937, 1957).

Sexual plants have been reported before only by Aziz (1967). Spermatangial clusters vary considerably in size both within and between populations. In some cases the cluster is densely branched and bears numerous spermatangia, while in others it remains small, and in some cases spermatangia are even borne directly on vegetative cells or on unicellular stalks (Figs. 29-31).

It appears that the trichogynes of unfertilized carpogonia continue to elongate until a spermatium lands on the tips (Fig. 22). Only several fertilized carpogonia with clear transverse divisions have been observed (Fig. 25), and further study is needed to determine whether gonimoblast cells are cut off without such a division first occurring.

Critical comparisons of the type and other collections of *Audouinella dasyae, Acrochaetium intermedium* Jao (1936, p. 242, pl. 11, Figs. 1-4), and *Acrochaetium zosterae* Papenfuss (1945, p. 307 = *A. subseriatum* Jao 1936, p. 243, pl. 11, Figs. 5-7, non *A. subseriatum* Boergesen 1932, p. 118) indicates that all three taxa are conspecific (Table 3).

Jao (1936, p. 243) distinguished *A. intermedium* from *Audouinella dasyae* on the bases of an elongate rather than globose central cell, the presence of endophytic prostrate filaments, longer cells, more extensive branching, and the presence of bisporangia. However, all collections of *A. dasyae* examined, including the type, have panduriform or pyriform central cells at maturity, may or may not

produce accessory prostrate filaments, have cells of similar dimensions (Table 3), and contain plants with varying degrees of branching. Bisporangia have not been observed in the type collection material of *A. intermedium* examined during this study; however, the presence or absence of bisporangia (possibly incompletely divided tetrasporangia) alone does not warrant specific distinction (Woelkerling 1971). Since no other reliable distinguishing criteria could be found, the two taxa are considered conspecific. Aziz (1967) previously proposed that the two entities belonged to the same species.

Acrochaetium zosterae reportedly (data from Jao 1936, p. 244) differs from *Audouinella dasyae* in the shape of the central cell and in the larger size of monosporangia. Central cell shape of the two taxa is essentially the same (see above), and an examination of type material of *Acrochaetium zosterae* indicates that most monospores are 18-24 μm long and 8-11 μm wide rather than 22-31 μm long and 6.5-9.5 μm wide as reported by Jao (1936). The first set of dimensions falls within the range found for other New England populations of *Audouinella dasyae*. Since differences in host (*Dasya* vs. *Zostera*) are not taxonomically reliable (Woelkerling 1971) and since no other reliable criteria could be found to distinguish the two taxa, they are also considered conspecific.

Acrochaetium opetigenum Boergesen (1915, p. 38, Figs. 35-37), *A. robustum* Boergesen (1915, p. 40, Figs. 38-40), and *A. unipes* Boergesen (1915, p. 35, Figs. 31-35) are very similar to *Audouinella dasyae,* and a comparative examination of the type collections will probably show that all are conspecific. Boergesen (1915) separated all of these taxa on slight differences in prostrate system structure, but none appears to be taxonomically reliable (see Woelkerling 1971).

The relationships between *A. dasyae* and *Chantransia macounii* Collins (1913, p. 113) require further clarification. Collins (1913) states in the original description that the cell representing the original spore does not remain

distinct; Drew (1928, p. 184, pl. 43, Figs. 47-52, pl. 44, Fig. 53), however, describes and illustrates a distinct central cell which she says becomes obscured by other prostrate filaments. Both Drew's material and the type collection of Collins need to be re-examined and compared with *Audouinella dasyae* to determine whether any or all are conspecific.

Collins (1906, p. 192) suspected that specimens of Harvey (1853, p. 243) collected at Hell Gate, Long Island, New York in 1850 and referred to *Callithamnion virgatulum* Harvey were in reality plants of *Audouinella dasyae*. Harvey's original material from TCD has been examined and indeed contains only plants of *A. dasyae*, as suspected by Collins.

As noted previously, young plants of *A. dasyae* can under some circumstances become confused with specimens of *A. alariae*. The two can usually be distinguished on differences in basal cell shape.

4. **Audouinella daviesii** (Dillwyn) Woelkerling 1971: 28, Figs. 7, 22; 1973: 81. Figs. 32-43.

Acrochaetium daviesii (Dillwyn) Naegeli 1861: 405, Figs. 26-7. Baardseth 1941: 42, Fig. 18. Collins 1906: 194 (?); 1908: 134. Davis 1913: 813. Doty 1948: 263. Edelstein et al. 1970: 634. Hamel 1927: 39, 98, Fig. 31; 1928: 192; 1928a: 133, Fig. 31. South and Cardinal 1970: 2079. Taylor 1937: 234, pl. 31., Figs. 8-10; 1957: 221, pl. 31, Figs. 8-10.

Callithamnion daviesii (Dillwyn) Lyngbye 1819: 129 (only as to binomial). J. Agardh 1851: 11; 1876: 8. Jordan 1874: 197; 1874a: 488.

Ceramium daviesii (Dillwyn) C. Agardh 1817: XXVII.

Chantransia daviesii (Dillwyn) Thuret In LeJolis 1863: 106. Collins 1880: 162 (?); 1894: 233 (?); 1900: 49 (?); 1911: 276 (?). DeToni 1897: 67; 1924: 55. Farlow 1875: 376; 1876: 705. Kylin 1907: 117, Fig. 27. Rosenvinge 1909: 104, Fig. 34.

Conferva daviesii Dillwyn 1809: 73, Suppl. pl. F.

Rhodochorton daviesii (Dillwyn) Drew 1928: 172. Nakamura 1944: 106, Fig. 5.

Trentepohlia daviesii (Dillwyn) Areschoug 1847: 338. Farlow 1881: 109. Martindale 1889: 100.

Acrochaetium amphiroae (Drew) Papenfuss 1945: 312. Doty 1948: 263. Edelstein and McLachlan 1968: 993, Figs. 49-50 (?). Mathieson et al. 1969: 131. South 1970: 1. South and Cardinal 1970: 2079. Taylor 1957: 223.

Rhodochorton amphiroae Drew 1928: 179, pl. 40, Figs. 34-37.

Acrochaetium alcyonidii Jao 1936: 245, pl. 12, Figs. 2-4. Papenfuss 1945: 312. Taylor 1937: 234, pl. 34, Figs. 2-4; 1957: 200, pl. 34, Figs. 2-4.

Acrochaetium alcyonidii Jao var. *cylindricum* Jao 1936: 245, pl. 12, Fig. 5. Taylor 1937: 234, pl. 34, Fig. 5; 1957: 221, pl. 34, Fig. 5.

Acrochaetium sagraeanum auct. non. (Montagne) Bornet: Boergesen 1915: 35 (pro parte). Bornet 1904: XXI (pro parte). Collins 1906: 192 (pro parte). Hamel 1927: 77, 99 (pro parte); 1928: 173, 191 (pro parte). Jao 1936: 244 (pro parte). Papenfuss 1945: 311 (pro parte). Taylor 1960: 309 (pro parte). Vickers 1905: 60.

Chantransia sagraeana auct. non. (Montagne) DeToni: DeToni 1924: 51 (pro parte).

Chantransia corymbifera auct. non. Thuret In LeJolis (pro parte; see Papenfuss 1945, p. 313 under *Acrochaetium bornetii*): Collins 1896: 5. Collins, Holden, and Setchell 1896: 192.

Chantransia efflorescens var *thuretii* auct. non. Bornet: Collins 1906: 196. Davis 1913: 813.

Acrochaetium thuretii auct. non. (Bornet) Collins et Hervey: Taylor 1937: 236; 1957: 222.

Note: Additional synonomy is presented by Woelkerling (1971).

Plants partly to entirely epiphytic or epizoic, caespitose, up to 6 mm tall; original spore non-persistent. Prostrate system consisting of branched epi- or endophytic or epi- or endozoic filaments forming a pseudoparenchymatous

disc or an entangled funiform mass. Erect filaments moderately to freely and irregularly branched, sometimes tapering towards the tips or attenuate and ending in multicellular hair-like prolongations. Cells cylindrical, (6-) 9-12 (-20) μm wide and (8-) 15-50 (-70) μm long, L/D (1-) 2-4 (-6) in main axes and laterals; about 4 μm wide and up to 75 μm long in hair-like prolongations; each cell containing a single parietal lobate chromoplast with one pyrenoid.

Monosporangia ovoid, 7-13 μm wide and (8-) 12-20 μm long, in clusters of 3 or more on branched stalks or singly or in pairs on 1-2 celled stalks, situated on the lowermost cells of laterals or sometimes more scattered. Tetrasporangia ovoid, 16-22 μm wide and 24-36 μm long, borne in pairs on unicellular stalks or occasionally solitary or in groups of 3, situated on the lowermost cells of laterals or more scattered.

Spermatangia ovoid to spherical, up to 4 μm wide and 5 μm long, borne terminally or laterally in small clusters on branched stalks. Carpogonia terminal on unicellular stalks; immediate post-fertilization stages not observed. Mature carposporophyte consisting of branched gonimoblast filaments bearing terminal, ovoid carposporangia 9-18 μm wide and 18-26 μm long.

Type Locality: Bantry Bay, Ireland (Hutchens); locality for H. Davies collection not given by Dillwyn (1809).

Type: NMW.

Distribution: Nearly cosmopolitan.

Hosts: A wide variety of algae, and invertebrates.

Specimens examined:

MAINE: Eastport, 1873, *Averill* (?) (NY).

MASSACHUSETTS: Gay Head (Martha's Vineyard), VIII. 1875, *Farlow* (FH); (NY). Gloucester, IX. 1878, *Farlow* (FH). Marblehead, 16. IX. 1888, *Collins* (NY); 27. VIII. 1895, *Collins* (NY). Nantucket Center (Nantucket Is.), 14. IV. 1970, *Woelkerling* (WJW 2577). Old Silver Beach, 31. X. 1970, *Woelkerling* (WJW 2855); 30. XII. 1970, *Woelkerling* (WJW 2978), (WJW 2976). Salisbury Beach, 31. V. 1909, *Collins* (?) (NY). Waquoit (Harbor Entrance), 27. IV. 1970, *Woelk-*

erling (WJW 2536). West Falmouth Harbor, 3. X. 1970, *Woelkerling* (WJW 2769). West Yarmouth, 16. XI. 1969, *Woelkerling* (WJW 2248). Woods Hole (Butlers Point), 15-20. VII. 1895, *Nott* (FH [P.B.A. 192], NY, WIS [P.B.A. 192]). Woods Hole (Nobska Point), 4. II. 1970. *Woelkerling* (WJW 2332), (WJW 2322); 2. VII. 1970, *Woelkerling* (WJW 2678); 17. VII. 1970, *Woelkerling* (WJW 2719); 29. I. 1971, *Woelkerling* (WJW 3302); 12. II. 1971, *Fiore* (WJW 3320); 16. II. 1971, *Woelkerling* (WJW 3314). Woods Hole (Pine Island), 9. VII. 1938, *Taylor* (NY). Woods Hole (Sheep Pen Harbor), 1. IX. 1934, *Jao* (MICH, apparently a portion of type collection of *Acrochaetium alcyonidii* Jao).

NEW YORK: Montauk Point (Long Island), 20. I. 1970, *Woelkerling* (WJW 2198).

CANADA: Paddy's Head (Nova Scotia), 13. X. 1965, *Edelstein* (Herb Nat. Res. Council, Halifax, 2110).

IRELAND: Bantry Bay, prior to 1809, *Hutchins* (NMW, Dillwyn collection, type).

Audouinella daviesii is distinguished from other New England audouinelloid algae by the arrangement (at least in part) of monosporangia in clusters of 3 or more on branched stalks which are usually situated on the lowermost cells of lateral branches (Figs. 32-35). On some plants all monosporangia are borne in such clusters while on others, notably sexual and tetrasporangial plants, clustered monosporangia may not be very evident or numerous.

A. daviesii appears to be mainly a sublittoral plant although several populations have been found on *Fucus* in the lowermost littoral. It has been collected in New England in all months except March and June, but almost certainly occurs throughout the year. Sexual plants have been collected in July, August, and September (WJW 2678, FH, NY); tetrasporangial plants have appeared in January (WJW 2198).

The vegetative appearance of *Audouinella daviesii* varies considerably. When growing on *Codium*, for example, the prostrate system becomes an endophytic funiform mass of filaments lodged between the utricles of the host. When growing on *Chondria*, in contrast, the prostrate system forms an epiphytic pseudoparenchymatous disc. Similar variation has been found in Australian populations of *A. daviesii* (Woelkerling 1971). Intergrades between these

forms also occur. The ratio of cell length to cell diameter also shows considerable variation. In some populations, most plants have cells with an L/D over 3 (Fig. 32) while in other populations, the ratio of cell length to cell diameter is almost always less than 3 (Fig. 33). Intergrades always occur, and sometimes transitions from short cells to longer cells can be found along single filaments (Fig. 34).

Other vegetative features which vary include the degree of branching and the occurrence of multicellular hair-like prolongations. In some plants the degree of branching is only moderate; laterals arise at infrequent intervals and are little further divided. In other plants, however, branching is abundant and laterals often arise in groups in close proximity to one another in a more or less fasciculate manner. Hair-like prolongations occur in some populations but not in others. Often these prolongations were broken off giving the lateral branches a stubby appearance.

Several sexual and one tetrasporangial collection have been made in New England waters to date. Unfortunately, immediate post-fertlization stages have still not been observed (see Woelkerling 1971) and it is not known whether the fertilized carpogonium divides transversely, longitudinally, or gives rise directly to gonimoblast filaments. Carposporangia in the New England populations tend to be larger than those found in Australia (Woelkerling 1971).

Acrochaetium alcyonidii Jao (1936, p. 245, pl. 12, Figs. 2-4) and *A. alcyonidii* var. *cylindricum* Jao (1936, p. 245, pl. 12, Fig. 5) are here considered conspecific with *Audouinella daviesii*. Two slides labelled "alcyonidii" by Jao in MICH, which are presumably from the original collection but do not bear the number Woods Hole 279 (see Jao 1936, p. 245), have been examined and found to contain only the basal portions of several plants without any monosporangia or other reproductive structures. Thus the material is unidentifiable.

The published accounts and illustrations of Jao (1936) and Taylor (1937, 1957) leave little doubt about the con-

specificity of *Acrochaetium alcyonidii* and *Audouinella daviesii.* Jao (1936) separated the former from the latter ". . . in having a strongly marked endozoic habit and very short lateral branches." However, host differences, habit, and length of lateral branches appear to be of little taxonomic significance (Woelkerling 1971). Moreover several New England populations (Taylor, Pine Island Coll. in NY; WJW 3320) growing on *Alcyonidium* (the host of *Acrochaetium alcyonidii*) have been examined and found to agree in all essential respects with *Audouinella daviesii.* In light of these considerations, and because no other criteria of taxonomic significance are apparent (the presence of bisporangia, reported by Jao (1936) but not seen during this study, does not alone appear to be sufficient grounds for species separation), *Audouinella daviesii* and *Acrochaetium alcyonidii* are considered conspecific.

Acrochaetium amphiroae (Drew) Papenfuss has already been referred to the conspecificity of *Audouinella daviesii* (Woelkerling 1971); consequently the records of Doty (1948), Mathieson *et al.* (1969), South (1970), and Taylor (1957) are referred (at least as to name) to *A. daviesii.* None of the collections upon which these records are based, however, has been available for examination.

A number of collections of other investigators have been examined and apparently found not to contain plants of *A. daviesii.* Specimens which Harvey (1853, p. 243) referred to *Callithamnion daviesii* belong to *Colaconema secundata.* With one exception (see specimens examined listing), all the collections of Collins examined, both in FH and NY, including Phycotheca Boreali Americana Specimen No. 880, have been found not to contain plants of *A. daviesii* but rather plants referable to *Colaconema secundata.* Since there is a slight possibility that both taxa are present in Collins material, Collins references are listed with question marks in this account. The uncertainty over Collins material leads to uncertainty over the reported distribution of *A. daviesii* in the New England region; in addition to a number of stations in Massachu-

setts, *A. daviesii* is also definitely known from only one locality in Maine and one in New York as a result of the present study.

Plants from Nova Scotia referred to *Acrochaetium alcyonidii* (Edelstein *et al.* 1967) and *A. amphiroae* (Edelstein and McLachlan 1968) should be checked; one collection sent from Dr. Edelstein and identified as *A. alcyonidii* has been examined and found to contain only plants of *Colaconema membranacea* (Magnus) comb. nov. Likewise, the illustrations (Edelstein and McLachlan 1968, Figs. 49-50) of plants referred to *Acrochaetium amphiroae* leave considerable doubt as to their true relationship to *Audouinella daviesii.*

A number of specimens hitherto referred to *Acrochaetium sagraeanum* (Montagne) Bornet have been examined and found to be *Audouinella daviesii;* citations are appended. The type of *Acrochaetium sagraeanum* has been excluded from the Rhodophyta (see "Species Excludendae").

Massachusetts specimens collected by Collins in 1888 and 1895 from Marblehead, by Farlow in 1875 from Gay Head (Martha's Vineyard; host is *Cystoclonium*), and by Nott in 1895 from Butler's Point (Woods Hole) in FH and NY have been examined during this study and found to contain sexual plants of *Audouinella daviesii* and, in several instances, a plant or two of *Colaconema secundata.* In the literature, these collections have been referred erroneously to *Chantransia corymbifera* (Collins 1896; Collins, Holden, and Setchell 1896, No. 192), *C. efflorescens* var. *thuretii* (Collins 1906, Davis 1913), and/or *Acrochaetium thuretii* (Taylor 1937, 1957). The vast majority of plants examined in the above populations contained numerous carposporophytes and very few monosporangia. In each case, however, the few monosporangia found tended to be arranged in axial clusters of 3-4 on branched stalks, and this is the characteristic arrangement found in *Audouinella daviesii.* In other respects these populations agree well with sexual plants collected during this study. For

additional information, see comments below under *Audouinella efflorescens.*

5. **Audouinella microscopica** (Naegeli In Kuetzing) Woelkerling 1971: 33, Figs. 10, 23A. 1972: 85 et seq., Figs. 1-14; 1973: 86. Figs. 46-51.

Acrochaetium microscopicum (Naegeli In Kuetzing) Naegeli 1861: 407, Figs. 24-25.

Callithamnion microscopicum Naegeli In Kuetzing 1849: 640.

Chantransia microscopica (Naegeli In Kuetzing) Batters In Schiffner 1916: 136, Figs. 13-18.

Chromastrum microscopicum (Naegeli In Kuetzing) Papenfuss 1945: 322.

Kylinia microscopica (Naegeli In Kuetzing) Kylin 1944: 13. Papenfuss 1947: 437.

Rhodochorton microscopicum (Naegeli In Kuetzing) Drew 1928: 151, 163.

Acrochaetium catenulatum Howe 1914: 84, pl. 31, Figs. 12-18.

Chantransia catenulata (Howe) DeToni 1924: 44.

Kylinia catenulata (Howe) Kylin 1944: 13.

Rhodochorton catenulatum (Howe) Nakamura 1941: 273, 280, Fig. 1.

Acrochaetium collopodum (Rosenvinge) Hamel 1927: 81; 1928: 175.

Chantransia collopoda (Rosenvinge) Rosenvinge 1909: 81.

Chromastrum collopodum (Rosenvinge) Papenfuss 1945: 320.

Kylinia collopoda (Rosenvinge) Kylin 1944: 13, 15, Fig. 6.

Acrochaetium compactum Jao 1936: 241, pl. 10, Figs. 6-14. Taylor 1937: 228, pl. 32, figs. 6-14.

Chromastrum compactum (Jao) Papenfuss 1945: 321.

Kylinia compacta Papenfuss 1947: 436. South 1970: 1. Taylor 1957: 212, pl. 32, Figs. 6-14.

Acrochaetium crassipes (Boergesen) Boergesen 1915: 20, Figs. 11-13. Boergesen 1927: 12, Fig. 5. Collins and

Hervey 1917: 96. Howe 1918: 511. Taylor 1941: 75.

Chantransia crassipes Boergesen 1909: 1, Fig. 1. Taylor 1928: 134, pl. 28, Fig. 16.

Chromastrum crassipes (Boergesen) Papenfuss 1945: 321.

Kylinia crassipes (Boergesen) Kylin 1944: 13. Taylor 1960: 300.

Acrochaetium microfilum Jao 1936: 240, pl. 10, Figs. 1-5. (Non *A. microfilum* Levring 1945: 12, Fig. 4. = *A. levringii* Papenfuss 1947: 436). Taylor 1937: 232, pl. 32, Figs. 1-5; 1957: 219, pl. 32, Figs. 1-5.

Acrochaetium moniliforme (Rosenvinge) Boergesen 1915: 22. Jao 1936: 241, pl. 10, Figs. 15-17. Taylor 1937: 227, pl. 32, Figs. 15-17.

Chantransia moniliformis Rosenvinge 1909: 99, Figs. 28-29.

Chromastrum moniliforme (Rosenvinge) Papenfuss 1945: 322.

Kylinia moniliformis (Rosenvinge) Kylin 1944: 13. South 1970: 1. Taylor 1957: 211, pl. 32, Figs. 15-17.

Rhodochorton moniliforme (Rosenvinge) Drew 1928: 151, 164.

Chantransia secundata auct. non. (Lyngbye) Thuret: Hauck and Richter 1892: 454.

Plants epiphytic, up to 100 μm tall exclusive of hairs; original spore persisting as a unicellular base slightly smaller to slightly larger than other cells. Filaments of erect system 1-4, commonly arcuate, simple or with a few secundly to irregularly arranged lateral branches. Cells barrel-shaped to cylindrical, 3-10 μm wide and 3-11 μm long, L/D 0.75-2; each cell containing a single parietal lobate to stellate chromoplast with one pyrenoid. Terminal hairs up to 40 μm long occur occasionally.

Monosporangia ovoid, 4-9 μm wide and 6-15 μm long, terminal or lateral, single or rarely in pairs, sessile or stalked, adaxially seriate or occasionally more scattered.

Other reproductive structures not observed in New England populations.

Type locality: Torquay, England.

Type: L, No. 940285 . . . 306.

Distribution: Nearly cosmopolitan.

Hosts: Chaetomorpha, Chordaria, Cladophora, Enteromorpha, Polysiphonia, and *Sphaerotrichia* in New England; a wide variety of algae and bryozoans elsewhere.

Specimens examined:

MASSACHUSETTS: Black Rock, Sconticut Neck, New Bedford, 25. VII. 1934, *Jao* (MICH, Woods Hole, No. 275, type of *Acrochaetium compactum* Jao). Cape Codder Point, Falmouth 19. XI. 1969, *Woelkerling* (WJW 2292). Norton Point, Martha's Vineyard, 3. VIII. 1934, *Jao* (MICH, Woods Hole, No. 280 [not 274 as reported by Jao 1936, p. 240], type of *Acrochaetium microfilum* Jao). West Falmouth Harbor, 17. X. 1970, *Woelkerling* (WJW 2826). Woods Hole (Nobska Point), 4. II. 1970, *Woelkerling* (WJW 2320).

ENGLAND: Torquay, 1845, Naegeli (L 940285 . . . 306, type of *Audouinella microscopica* (Naegeli) Woelkerling). Torquay, 1845, *Naegeli* (FH = Hauck and Richter 1892, No. 454, isotype of *A. microscopica,* which is labeled *Chantransia secundata*). Torquay, 1845, Naegeli (NY = Hauck and Richter 1892, No. 454, isotype of *A. microscopica,* which is labeled *Chantransia secundata*).

Audouinella microscopica is distinguished from other New England audouinelloid algae with a unicellular base 1) in commonly having cells isodiametric or broader than long; 2) in having a more or less globose basal cell protoplast that is not markedly flattened on the side in contact with the substrate; and 3) in having erect or ascending rather than procumbent filaments.

A detailed morphotaxonomic account of this species in New England and adjacent regions has recently appeared in the literature (Woelkerling 1972). To date this species has been collected only from Massachusetts along the New England coast, but it is known from Nova Scotia (Edelstein and McLachlan 1966, 1968; Edelstein et al. 1967; South and Cardinal 1970) and, therefore, is to be expected at intermediate points. Although collection data is incomplete, *A. microscopica* probably is present throughout the year and is to be sought on any older, epiphytized algae. Its microscopic size may account for its being generally overlooked.

6. **Audouinella saviana** (Meneghini) comb. nov. Figs. 56-60.

Acrochaetium savianum (Meneghini) Naegeli 1861: 405. Feldmann 1942: 218. Hamel 1927: 41, 98, Fig. 32; 1928: 192; 1928a: 135, Fig. 32. Papenfuss 1945: 311; 1947: 435.

Callithamnion savianum Meneghini 1840: 511. J. Agardh 1851: 14; 1876: 6. Kuetzing 1849: 641.

Chantransia saviana (Meneghini) Ardissone 1883: 276 (pro parte). DeToni 1897: 68.

Chantransia efflorescens var. *thuretii* Bornet 1904: XVI, pl. 1.

Acrochaetium thuretii (Bornet) Collins et Hervey 1917: 98. Doty 1948: 263. Hamel 1927: 37, 97, Fig. 30. 1928: 191; 1928a: 131, Fig. 30. Kylin 1944: 21, Fig. 14. Papenfuss 1945: 311.

Audouinella thuretii (Bornet) Woelkerling 1971: 36, Figs. 12, 24; 1973: 88.

Chantransia thuretii Bornet. Collins 1900: 49 (nom. nud.).

Chantransia thuretii (Bornet) Kylin 1907: 119, Fig. 28. Rosenvinge 1909: 100, Figs. 30-33.

Rhodochorton thuretii (Bornet) Drew 1928: 171.

Acrochaetium sagraeaum auct. non. (Montagne) Bornet: Boergesen 1915: 35 (pro parte). Bornet 1904: XXI (pro parte). Collins 1905: 231 (pro parte); 1906: 192 (pro parte). Collins and Hervey 1917: 97. Collins, Holden, et Setchell 1917: 2181. Hamel 1927: 77, 99 (pro parte); 1928: 173, 191 (pro parte). Hylander 1928: 159 (pro parte) Jao 1936: 244 (pro parte). Papenfuss 1945: 311 (pro parte). Taylor 1937: 233 (pro parte); 1957: 220 (pro parte); 1960: 309 (pro parte).

Chantransia sagraeana auct. non. (Montagne) DeToni: DeToni 1924: 51 (pro parte).

Chantransia virgatula auct. non. (Harvey) Thuret In LeJolis: Collins 1900: 49 (pro parte). Collins, Holden, et Setchell 1895: 39. Hylander 1928: 158.

Plants partly to entirely epipytic, caespitose, up to 4 mm

tall; original spore non-persistent. Prostrate system composed of short, simple or branched filaments free from one another or united into an irregularly shaped pseudoparenchymateous disc. Erect filaments moderately to freely and irregularly branched. Cells cylindrical, (7-) 8-12 (-14) μm wide and 20-60 μm long [L/D 2-6(-8)] in main axes and laterals, sometimes tapering to 4-6 μm wide near the tips; each cell containing a single parietal lobate chromoplast and one pyrenoid. Unicellular hairs unknown.

Monosporangia ovoid, 10-15 μm wide and 18-27 μm long, sessile or stalked, single or in pairs, in a secund series along the laterals or more scattered. Tetrasporangia ovoid, 17-24 μm wide and 26-34 μm long, sessile or stalked, single or in pairs, scattered on the erect filaments.

Other reproductive structures not observed.

Type locality: Genoa, Italy.
Type: FL.
Distribution: Nearly cosmopolitan.
Hosts: A variety of algae and marine angiosperms.

Specimens examined:
MASSACHUSETTS: Sandwich Jetty (Cape Cod Canal), 13. X. 1970, *Woelkerling* (WJW 2818). West Yarmouth, 17. IX. 1969, *Woelkerling* (WJW 2253); 3. X. 1969, *Woelkerling* (WJW 2256). Waquoit Bay (Falmouth), 30. VI. 1969, *Conway* (WJW 1839); 15. IX. 1969, *Conway* (WJW 1840). Woods Hole (Eel Pond), 21. VII. 1970, *Wilce* (WJW 2753). Woods Hole (Nobska) 17. VII. 1970, *Woelkerling* (WJW 2722). Woods Hole, 1876, *Dudley* (WJW 3284).
FRANCE: Cherbourg, 1. IX. 1856, *Bornet* [PC, possibly the type of *Acrochaetium thuretti* (Bornet) Collins et Hervey].
ITALY: Genoa, (8. VI ?). 1839, *Meneghini* (FI, type of *Callithamnion savianum* Meneghini).

Audouinella saviana is distinguished from other New England audouinelloid algae of similar morphology in having a filamentous to pseudoparenchymatous prostrate system without an enlarged panduriform or pyriform cell and having the monosporangia solitary or in pairs on simple stalks rather than in clusters on branched stalks.

Audouinella saviana appears to be confined to the sublittoral and lowermost littoral in New England waters and

has been collected in June, July, September and October as an epiphyte on various algae including *Champia*, *Chondria*, and *Stilophora*. Tetrasporangial plants have been collected in October; sexual plants have not been found in New England waters, but are described in detail by Kylin (1907) and Rosenvinge (1909) [both as *Chantransia thuretii*]. Additional study may reveal that the species is present in New England during all or most of the year.

The vegetative system shows considerable variation in New England populations. In some cases, the prostrate system is quite reduced while in others it is comparatively robust. The L/D ratio of cells also varies considerably. In some plants, most cells are 4-8 diameters long; in others they are mostly 2-4 diameters long; and in still others they show a combination of both of the above (Figs. 57, 59-60).

Acrochaetium thuretii (Bornet) Collins et Hervey is here considered conspecific with *Audouinella saviana* after comparing specimens from the type collections of the two taxa. Material from FI and PC agree in all essential respects with one another and with New England populations (Table 4; also see Addendum).

Plants referable to *Audouinella saviana* appear to be widely distributed, but have usually been reported under the specific epithet "thuretti" while the epiphet "saviana" has persisted in relative obscurity. Hamel (1927, 1928a) attempted to distinguish the two taxa on the bases of presence or absence of sexual structures and on the relative L/D ratio of cells, but neither of these criteria appears systematically reliable.

A number of specimens hitherto referred to *Acrochaetium sagraeanum* (Montagne) Bornet have been examined and found to be *Audouinella saviana;* citations have been appended. The type specimen of *Acrochaetium sagraeanum* has been excluded from the Rhodophyta (see "Species Exludendae").

The literature references of Collins (1896, 1906), Collins, Holden, and Setchell (1896), Davis (1913), and Taylor (1937, 1957) to specimens under the names of *Chan-*

transsia corymbifera, *C. efforescenes* var. *thuretii*, and/or *Acrochaetium thuretii* are based on misidentifications. These collections have been re-examined and found to contain plants of *Audouinella daviesii;* for further discussion, see the account of that species.

The relationships of *A. saviana* to a number of taxa of similar morphology await clarification. These include *Acrochaetium avrainvillae* Boergesen (1915, p. 48, Figs. 47-49), *A. hypneae* Boergesen (1909), and *A. pallens* (Zanardini) Naegeli (See Hamel 1927, p. 48). All of these taxa appear to be very similar to *Audouinella saviana* and a comparison of type collections may show some or all to be conspecific.

The precise publication date of Meneghini's original diagnosis of *Callithamnion savianum* requires further comment. The issue of Flora (Regensburg) containing the diagnosis is dated 28 August 1840; however reference is made on p. 511 of that issue to prior publication of diagnosis on 23 May 1840 in a Pisa "Giornale" (= journal?, newspaper?).

Copies of a three page type-set document dated 23 May 1840 which resemble a journal reprint and are entitled "Lettera del Prof. Giuseppe Meneghini at Dott. Jacob Corinaldi a Pisa" are located at FI and PC (Dr. Paul Silva, personal communication); Prof. Peter S. Dixon has kindly sent me a photocopy of the PC document. Hamel (1927, 1928) also has made reference to this document. The PC copy unfortunately provides no clues as to the original place of publication other than three words — "Pisa Tipografia Prosperi" — written in longhand at the bottom of the first page, and until further light can be shed on the matter of its original place of publication (if, indeed, there was one), it seems wise to continue to refer to the "Flora" article when citing Meneghini's original diagnosis of *Callithamnion savianum* since the wording of the diagnosis in "Flora" is identical to that in the PC document.

7. **Audouinella unifila** (Jao) comb. nov. Figs. 44-45.
Acrochaetium unifilum Jao 1936: 239, pl. 10, Figs. 26-32.

Taylor 1937: 228, pl. 32, Figs. 26-32. Non. *A. unifilum* Levring 1953: 472, Fig. 9 (= *Colaconema nakamurai* Woelkerling 1971: 46, Fig. 16).

Chromastrum unifilum (Jao) Papenfuss 1945: 322.

Kylinia unifila (Jao) Papenfuss 1947: 437. Taylor 1957: 212, pl. 32, Figs. 26-32.

Audouinella australis (Levring) Woelkerling 1971: 25, Figs. 4-5.

Kylinia australis Levring 1953: 487, Figs. 21A-C. Boney and White 1967: 595.

Plants epiphytic, up to 150 μm tall; original spore persisting as a hemispherical unicellular base appressed to the substrate and usually giving rise to a single erect filament. Erect filament(s) procumbent to semi-upright, simple or rarely with 1-2 celled laterals. Cells cylindrical, 6-8 μm wide and 8-20 μm long, L/D 1-3, each cell containing a single parietal lobate to stellate (Jao 1936) chromoplast and one pyrenoid. Terminal and pseudolateral hairs up to 50 μm long occur.

Monosporangia ovoid, 5-7 μm wide and 8-14 μm long, sessile or occasionally on unicellular stalks, scattered along the erect filament(s).

Other reproductive structures not observed in New England populations.

Type Locality: Norton Point, Martha's Vineyard, Massachusetts.

Type: MICH, Woods Hole No. 274.

Distribution: Massachusetts; South Australia.

Hosts: *Arthrocladia villosa* Duby, *Audouinella* sp.

Specimens examined:

MASSACHUSETTS: Norton Point (Martha's Vineyard), 3. VIII. 1934, *Jao* (Michigan, holotype).

AUSTRALIA: Pennington Bay (Kangaroo Island), 7. II. 1947, *Womersley* (ADU, A31373, isotype of *Kylinia australis* Levring). Note: Other Australian collections examined are cited in an earlier paper (Woelkerling, 1971, p. 26).

Audouinella unifila is distinguished from other New England audouinelloid algae with a unicellubar base by

the procumbent development of erect filaments and the characteristically flattened (compressed) hemispherical basal cell. . .

The one known New England collection of this taxon is the type collection, plants of which are on the permanent slides in MICH. Only monosporangial specimens occur, and the range of cell and spore dimensions of these plants is somewhat greater than reported originally by Jao (1936). Chromoplasts were not recognizable, but at least one pyrenoid was observed.

Critical comparisons of the type collections of *A. unifila* and *A. australis* strongly indicate that the two taxa are conspecific. Monosporangial plants of both taxa show virtually identical ranges of cell and spore dimensions and in general have the same habit. Apparent differences in chromoplast shape (Jao, 1936, reported stellate plastids in *A. unifila;* Levring (1953) recorded parietal plastids in *A. australis*) do not appear to be taxonomically significant (see Woelkerling 1971, p. 14). Woelkerling (1971, p. 26) previously noted similarities in the two taxa.

Although sexual plants do not occur in the type collection, this taxon is referred to *Audouinella* on the basis of the rather common occurrence of sexual plants in South Australian populations.

Some questions may be raised as to the relationships between *Audouinella unifila* and *A. microcopica.* The author's experience to date indicates that the two have quite distinct basal cells and modes of erect filament development, and no intermediates have been observed. However, the possibility exists that such intermediates do occur and they should be watched for.

COLACONEMA Batters

Colaconema Batters 1896: 8. Woelkerling 1971: 40. Non *Colaconema* Schmitz In Schmitz and Falkenberg 1897: 452.

Note: Species not referable to *Colaconema* have been placed in the past in *Acrochaetium, Audouinella, Calli-*

thamnion, Ceramium, Chantransia, Chromastrum, Kylinia, Rhodochorton, and/or *Trentepohlia.*

Plants epibiotic, endobiotic, or saxicolous; attached to or suspended in the substrate by a single-celled holdfast or more commonly by a prostrate system of simple or branched filaments, which may or may not become pseudoparenchymatous. Erect filaments, when present, simple or branched, up to 10 mm tall; cells containing one to a number of variously shaped chromoplasts with or without pyrenoids.

Asexual reproduction by sessile or stalked monosporangia, bisporangia, tetrasporangia, and/or multipartite sporangia borne on the erect and/or prostrate filaments.

Sexual reproduction unknown.

Type Species: Colaconema bonnemaisoniae Batters.

Section I

The species in this section are not known to contain pyrenoids in their chromoplasts.

8. **Colaconema membranacea** (Magnus) comb. nov. Figs. 64-65.

Audouinella membranacea (Magnus) Papenfuss 1945: 326; 1947: 438. Edelstein and McLachlan 1966a: 1052. Taylor 1957: 224, pl. 31, Figs. 11-12.

Callithamnion membranaceum Magnus 1874: 67, tab. II. Figs. 7-15. Collins 1883: 56; 1888: 10.

Rhodochorton membranaceum (Magnus) Hauck 1885: 69 (only as to binomial). Collins 1894: 230; 1900: 51. 1911: 280. Collins, Holden and Setchell 1895a: 99. Davis 1913: 818. DeToni 1903: 1513. Drew 1928: 186. Hamel 1927: 59, 109, Fig. 39A-E; 1928: 202; 1928a: 152, Fig. 39A-E. Hauck and Richter 1888: 154. Hylander 1928: 169. Kuckuck 1897: 337 et seq., Figs. 1-7. Taylor 1937: 240, pl. 31, Figs. 11-12.

Plants endozoic; original spore non-persistent. Prostrate system consisting of irregularly branched filaments of

indefinite length which may be free from one another or pseudoparenchymatously united into a sheet-like endozoic thallus. Cells of prostrate filaments cylindrical to irregular in shape, 8-60 μm long, and 5-11 μm wide, L/D 0.75-5(-8): each cell containing several to many discoid or irregularly shaped chromoplasts (sometimes becoming more or less spirally twisted) without pyrenoids. Erect filaments, when present, simple or sparingly and irregularly branched, rarely more than 25 cells long. Cells 10-45 μm long and 7-13 μm wide, L/D 1-4.

Tetrasporangia ovoid to globose, 10-15 μm wide and 16-25 μm long, solitary, sessile or occasionally stalked, terminal or rarely lateral on erect filaments or on prostrate filaments.

Type locality: Store Baelt Channel, between Sporogoe Island and Korsoer, Denmark.

Type: ?

Distribution: Europe and cooler waters of both coasts of North America.

Hosts: A variety of marine invertebrates, especially hydroids.

Specimens examined:

CONNECTICUT: Charles Island (Milford Channel), 22. IV. 1889, *Holden* (NY).

MAINE: Eagle Island, VII. 1894, *Collins* (NY).

MASSACHUSETTS: Brandt Point (Marshfield), 7. IV. 1968, *Greenwich* (NHA). Gay Head (Martha's Vineyard), 3. VIII, 1948, *Doty* (U. Hawaii). Marblehead, 30. V. 1884, *Collins* (NY). Martha's Vineyard, 16. VII. 1941, *Taylor* (FH). Nahant, 14. V. 1882. *Collins* (NY); 1. V. 1970, *Woelkerling* (WJW 2545). Revere Beach (Boston), IV. 1885, *Collins* (NY); 29. V. 1886, *Collins* (NY, FH = Hauck and Richter 1888, No. 154); 10. VI. 1894, *Collins* (NY). Sandwich Jetty (Cape Cod Canal), 13. X. 1970, *Woelkerling* (WJW 2812). Sconset Beach, 13. VIII. 1886, *Collins* (NY). Scusset Beach, 29. III. 1969, *LaPlante* (UNH). Woods Hole, 7. IV. 1968, *Logan* (NHA); 6. IV. 1968, *Kastelowitz* (NHA).

NEW HAMPSHIRE: Cedar Point (Dover), 21. XII. 1966, *Hehre* and *Conway* (NHA); 3. III. 1967 *Hehre* (NHA). Hilton Park (Dover Point), 19. III. 1967, *Hehre* and *Conway* (NHA); 27. IV. 1967, *Hehre* and *Stone* (NHA). Rye Ledge, 5. II. 1970, *Woelkerling* (WJW 2336).

NEW YORK: Montauk Point (Long Island), 20. I. 1970, *Woelkerling* (WJW 2258).

Colaconema membranacea is distinguished from other New England audouinelloid algae in having several to many irregular to discoid to spiral chromoplasts without pyrenoids and in having solitary tetrasporangia that are borne in a sessile condition or on simple stalks rather than in clusters on branched gonimoblast filaments. In addition, this species is known to occur only as an endozoophyte in hydroids and several other types of invertebrates, and while this in itself is no criterion of specific distinction, it can serve as a useful ecological guide for identification purposes.

Colaconema membranacea has been collected throughout the year in New England waters and commonly occurs on hydroids in both the intertidal zone (especially hydroids attached to *Ascophyllum* or *Fucus* in shaded habitats) and the sublittoral zone. Often the hydroids become reddish as a result of the algal infestation.

Among New England populations, the nature of the vegetative system varies considerably. In lightly infested host animals, the prostrate filaments tend to remain largely free from one another, but under more crowded conditions, the prostrate system becomes pseudoparenchymatous and all traces of a filamentous character are lost (Fig. 64). In most populations the erect system is entirely suppressed and sporangia, when present, are borne directly on the prostrate filaments. In a few instances, however, the erect systems were more highly developed and consisted of branched filaments up to 750 μm long.

The nature of the life cycle of this species awaits clarification by means of culture studies, and until such time, it is difficult to suggest definite relationships between *C. membranacea* and other audouinelloid algae. Thus, for example, *Rhodochorton concrescens* (see West 1970a) and *Audouinella purpurea* (see West 1969, 1970) share a number of morphological features with *Colaconema membranacea*, but apparently they have quite different types of life cycles.

The relationships of *C. membranacea* to *Callithamnion entozoicum* Reinsch in Giard (1890) are discussed under the latter species in the section on Species Inquirendae.

Section II

Species in this section have chromoplasts each with only one pyrenoid.

9. **Colaconema humilis** (Rosenvinge) Woelkerling 1971: 44, Figs. 15J-O. Figs. 66-73.

Acrochaetium humile (Rosenvinge) Boergesen 1915: 23. Baardseth 1941: 41. Jorde et Klavestad 1963: 76. Kylin 1944: 22, Fig. 17. Levring 1953: 478. Schiffner 1931: 143. Sundene 1953: 185.

Chantransia humilis Rosenvinge 1909: 117, Figs. 44, 45. Boergesen 1927: 21. Levring 1935: 37, Figs. 7F-S; 1937: 89; 1940: 78, Figs. 23A-B; 1942: 8.

Chromastrum humile (Rosenvinge) Papenfuss 1945: 323.

Kylinia humile (Rosenvinge) Papenfuss 1947: 437.

Rhodochorton humile (Rosenvinge) Drew 1928: 151, 169.

Acrochaetium radiatum Jao 1936: 246, pl. 10, Figs. 18-25. Edelstein et al. 1967: 196. Papenfuss 1945: 310. South and Cardinal 1970: 2079. Taylor 1937: 237, pl. 32, Figs. 18-25; 1957: 223, pl. 32, Figs. 18-25.

Plants epiphytic, up to 60 μm tall exclusive of hairs; developing from septate or occasionally aseptate spores. Prostrate system consisting of 2-6 simple or sparsely branched filaments up to 300 μm long, arising from the spore and creeping or forming an irregular, more or less pseudoparenchymatous disc. Cells of prostrate filaments cylindrical or occasionally somewhat subglobose, 6-14 μm long and 4-8 μm wide, L/D 1-2; each cell containing a single chromoplast and one pyrenoid. Erect filaments absent to numerous, simple or sparsely irregularly branched, generally less than 10 cells long; cell dimensions similar

to those of prostrate filaments. Unicellular hairs up to 100 μm long occur.

Monosporangia ovoid, 7-14 μm long and 5-8 μm wide, solitary or occasionally in pairs, sessile or stalked, scattered on prostrate or erect filaments.

Other reproductive structures unknown.

Type locality: Spodobjerg, Langeland, Denmark.

Type: C.

Distribution: Massachusetts; Nova Scotia; Australia; Atlantic and Mediterranean shores of Europe.

Hosts: *Ectocarpus* and *Polysiphonia* in North America; a variety of algae elsewhere.

Specimens examined:

MASSACHUSETTS: Norton Point (Martha's Vineyard), 3. VIII. 1934, *Jao* (MICH, Woods Hole No. 280, type of *Acrochaetium radiatum* Jao). West Falmouth (Harbor), 3. X. 1970, *Woelkerling* (WJW 2767). West Yarmouth, 12. XII. 1969, *Woelkerling* (WJW 2259). Woods Hole (Nobska Point), 26. VI. 1969, *Conway* (WJW 1838); 4. II. 1970, *Woelkerling* (WJW 2329).
NOVA SCOTIA: Ketch Harbor, 31. V. 1965, *Edelstein* (Herb. Nat. Res. Coun., Halifax).

Colaconema humilis can be distinguished from other New England audouinelloid algae by the following combination of features (as found in the collections examined): 1) A reduced erect system with most filaments of 10 or fewer cells; 2) Cells of erect and prostrate filaments mostly less than two diameters long; and 3) Prostrate system more or less compact; filaments rarely over 500 μm long. The first and third criteria probably do not represent very soundly based systematic characters, but until they can be re-examined in light of additional New England and other collections, they have been offered as useful guides for species recognition in this instance.

C. humilis is known in New England waters from collections made in February, June, August, October, and December. Edelstein et al. (1967) report it from May

through September in Nova Scotia, and judging from this, it seems reasonable to think that it may occur throughout the year in this region.

The erect system varies considerably and may be suppressed altogether (Fig. 67), consist of a few several celled filaments (Figs. 69-70), or of a number of short rather densely crowded filaments (Fig. 73). Likewise the extent of the prostrate system varies according to available substrate space; on the finely filamentous *Ectocapus*, it consists of a very few cells (Fig. 71) but on a larger species of *Polysiphonia* it can spread out more (Fig. 73). Most germinating spores divide into two distinct daughter cells (Fig. 68) but others do not (Fig. 66). Chromoplasts have not been observed; Jao (1936) reports a parietal plastid, Rosenvinge (1909) found a stellate plastid, and Woelkerling (1971) found a variable plastid shape.

Several investigators (e.g. Baardseth 1941, p. 41; Woelkerling 1971, p. 45) have commented upon the possible conspecificity of a number of audouinelloid algae whose morphology is similar to *Colaconema humilis*. On the basis of the examination of the type and other populations, *Acrochaetium radiatum* Jao has been referred to the synomomy of *Colaconema humilis*. Jao (1936, p. 247) separated the two taxa on the basis of the former ". . . having more than two main filaments arising from the divided germinating spore and all the filaments arranged radiately and densely from the center of a fully developed thallus." The type collection of *Acrochaetium radiatum*, however, contains plants that have 2 as well as more than two filaments emanating from the germinating spore (Fig. 68), and has plants that are not densely radiate (Fig. 69) as well as ones that are (see Jao, 1936, pl. 10, Figs. 22-25). Thus the criteria of specific distinction offered by Jao do not appear to be taxonomically reliable, and the two taxa can be considered conspecific.

The relationships of *Colaconema humilis* to a number of similar taxa (see Baardseth 1941, p. 41 and Woelkerling

1971, p. 45 for names) remains unclear, but there is increasing doubt as to whether many of these are really distinct species. In the Nova Scotia population examined during this study, plants with varying degrees of erect system development occur side by side and agree morphologically with one or several of the taxa cited by Baardseth (1941) and/or Woelkerling (1971). Similar variation occurs among the New England populations. Final clarification must await a comparison of the various type collections (which in many cases represent the only reported collections), but is seems likely that a number of these taxa will eventually be reduced to synonomy.

10. **Colaconema minima** (Collins) comb. nov. Figs. 74-76.

Acrochaetium minimum Collins 1908: 133. Collins, Holden, and Setchell 1908: 1493. Davis 1913: 813. Hamel 1927: 89; 1928: 183. Papenfuss 1945: 316. Taylor 1937: 237; 1957: 222.

Chantransia minima (Collins) Collins 1911a: 186. DeToni 1924: 62.

Acrochaetium emergens (Rosenvinge) Weber van Bosse 1921: 194. Hamel 1927: 93; 1928: 186. Jao 1936: 247, pl. 13, Figs. 7, 7B. Papenfuss 1945: 314. Taylor 1937: 235; 1957: 221.

Chantransia emergens Rosenvinge 1909: 128, Fig. 55. DeToni 1924: 67.

Rhodochorton emergens (Rosenvinge) Drew 1928: 151, 188.

Plants epi- to endophytic; sporelings not observed. Prostrate system consisting of irregularly branched filaments of indefinite length creeping on the surface or between the superficial cells of the host. Cells of prostrate filaments cylindrical to irregular in shape, 5-25 (-44) μm long and 3-8 (-14) μm wide, L/D 1-6 (-8); each cell containing a parietal chromoplast and one pyrenoid. Erect filaments 1-5 (-25) cells long, simple or with a few short, irregularly

arranged laterals; cell dimensions similar to those of prostrate filaments.

Unicellular hairs not observed.

Monosporangia ovoid to globose to hemispherical, 5-12 μm long and 4-10 μm wide, solitary or occasionally in pairs, sessile or on 1-2 celled stalks, scattered on the prostrate or erect filaments.

Other reproductive structures unknown.

Type locality: Robinson's Hole, Elizabeth Islands, Massachusetts.

Type: FH.

Distribution: Massachusetts; Denmark; Norway.

Hosts: *Asparagopsis, Desmarestia, Polysiphonia.*

Specimens examined:

MASSACHUSETTS: Robinson's Hole (Elizabeth Islands), VIII. 1907, *Collins* (FH, type); (WIS, isotype). [Isotypes have been distributed as No. 1493 in Collins, Holden, and Setchell (1908).] Sandwich Beach (Cape Cod Canal), 30. VI. 1970, *Wilce* (WJW 2693); 11. VII. 1970, *Woelkerling* (WJW 2699).

DENMARK: Mollegrund (Hirshals), 8. VIII. 1899, *Rosenvinge* (C, Algae Marinae Danicae No. 6574, type of *Chantransia emergens* Rosenvinge).

As circumscribed here, *Colaconema minima* can be distinguished from other New England audouinelloid algae by the following combination of features: 1) A prostrate system of indefinite length bearing no or short (1-5 (-25)) celled erect filaments, 2) Sporangia under 15 μm long and 12 μm wide; 3) Cells with single chromoplasts with one pyrenoid each; commonly over two diameters long.

Colaconema minima is known from three Cape Cod, Massachusetts collections. The type and the WIS isotype of the species consist of dried specimens that have proven difficult to work with because of the matted and rather unresponsive (to resoaking and slide making) condition. Nevertheless it has been possible to study and illustrate (Fig. 75) a portion of type material. Cells up to 15 μm long and 7 μm wide and spores up to 11 μm long and

6 μm wide have been found and thus extend the maximum limits recorded for this material by Collins (1908) and Taylor (1937, 1957). Erect filaments of more than 8 cells and cells over 6 diameters long were not encountered.

The two other collections were found growing on *Asparagopsis* and showed over all agreement with the type, although a number of cells were over 15 μm long and sporangia occurred on both prostrate and erect filaments. The relationship of these collections to *Colaconema americana* Jao is discussed under that taxon, which is regarded here as a "Species Inquirendae."

Critical comparisons of the type collections of *C. minima* and *Chantransia emergens* Rosenvinge (1909, p. 128, Fig. 55) have resulted here in regarding the two taxa as conspecific. They agree in all essential respects (Figs. 74-76; Table 5). Jao (1936, p. 247, pl. 13, Figs. 7, 7B) recorded the latter from New England waters, and Taylor (1937, p. 226; 1957, p. 217) separated it from *Colaconema minima* on the basis of slight differences in spore width. A comparison of the type collections indicates that this apparent difference is of no taxonomic significance since spores 3-5 μm wide occur in both taxa.

The relationships of *Colaconema minima* to other audouinelloid algae of similar morphology require considerable clarification. *Acrochaetium endophyticum* Batters (1896, p. 386; see also Baardseth 1941, p. 45, Figs. 19E-G) [non *Rhodochorton endophyticum* Kylin 1907, p. 188, Fig. 40 = *Acrochaetium kylinii* Hamel 1927, p. 93; 1928, p. 187 [nec *Liagorophila endophytica* Yamada 1944, p. 16, Fig. 4 (see also Abbott 1966)] appears to have a virtually identical morphology, and when the types can be compared, the two taxa will almost certainly prove to be conspecific, with the specific epithet "endophyticum" having priority. Likewise *Colaconema americana* Jao and a number of other similar taxa almost certainly will be relegated to conspecificity when critical comparisons of types can be made.

11. **Colaconema secundata** (Lyngbye) Woelkerling 1973: 94, Figs. 7-8. Figs. 77-83.[1]

Callithamnion daviesii var. *secundatum* Lyngbye 1819: 129, pl. 41, Figs. β4-6.

Acrochaetium luxurians (J. Agardh) Naegeli 1861: 405.

Callithamnion luxurians J. Agardh 1851: 14. Hall 1876: 111. Harvey 1853: 242. Jordan 1874: 197; 1874a: 488.

Chantransia luxurians (J. Agardh) Kylin 1907: 117, Fig. 26.

Acrochaetium secundatum (Lyngbye) Naegeli 1861: 405. Collins 1906: 194. Davis 1913: 813; 1913a: 477. South 1970: 1. South and Cardinal 1970: 2079. Taylor 1937: 230, pl. 31, Figs. 1-3.

Callithamnion secundatum (Lyngbye) C. Agardh 1828: 187.

Ceramium secundatum (Lyngbye) C. Agardh 1824: 132.

Chantransia secundata (Lyngbye) Thuret In LeJolis 1863: 106. Collins 1900: 49; 1911: 276. Collins, Holden, and Setchell 1903: 1088. Davis 1913a: 462, 473, 474. Farlow 1875: 376; 1876: 705. Hylander 1928: 158. Kylin 1910: 28.

Chromastrum secundatum (Lyngbye) Papenfuss 1945: 323.

Kylinia secundata (Lyngbye) Papenfuss 1947: 437. Edelstein and McLachlan 1966a: 1052, Fig. 18. Hehre and Mathieson 1970: 206, 237. Mathieson et al. 1969: 132. Taylor 1957: 214, pl. 31, Figs. 1-3.

Acrochaetium subsimplex Levring 1953: 473, Figs.

[1]According to the "Programme and Abstracts of the Twenty-first Annual Meeting of the British Phycological Society" (3-5 January 1973), W. J. Borsje, Vrije University, Amsterdam, reported sexual stages of *Acrochaetium virgatulum* in culture. If his plants are the same as New England plants (which, no doubt, will prove to be the case), *Colaconema secundata* (syn. *Acrochaetium virgatulum*) will then be transferred to the genus *Audouinella* as *A. secundata* (Lyngbye) comb. nov. Borsje's abstract also appears in *Br. phycol. J.* 8: 204-5, 1973.

10A-D, 11. Non *Rhodochorton subsimplex* (Harvey) DeToni 1897: 1515.

Acrochaetium tenuissimum (Collins) Papenfuss 1945: 319.

Chantransia tenuissima (Collins) Kylin 1941: 5, Figs. le, f.

Colaconema tenuissima (Collins) Woelkerling 1971: 51, Fig. 21.

Rhodochorton tenuissimum (Collins) Drew 1928: 170, pl. 38, Figs. 26, 27.

Acrochaetium virgatulum (Harvey) Bornet 1904: XXII. Collins 1906: 193. Davis 1913: 813; 1913a: 477. Doty 1948: 264. Edelstein et al. 1970: 625. South and Cardinal 1970: 2079. Taylor 1937: 230. Taylor In Lewis 1924: 214.

A. virgatulum f. *luxurians* (J. Agardh) Collins 1906: 194. Collins, Holden, and Setchell 1906: 1393. Hylander 1928: 159. Taylor 1937: 230, pl. 31, Figs. 4-7.

A. virgatulum f. *tenuissimum* (Collins) Collins 1906: 194.

Callithamnion virgatulum Harvey In Hooker 1833: 349. Jordan 1874a: 17.

Chantransia virgatula (Harvey) Thuret In LeJolis 1863: 106. Collins 1880: 162; 1894: 233; 1900: 49; 1911: 276. Davis 1913a: 462, 473, 474. Farlow 1875: 376; 1876: 705. Farlow, Anderson, and Eaton 1881: 157. Grier 1925: 296. Jelliffe 1904: 98. Hylander 1928: 158. Kylin 1910: 28. Rosenvinge 1909: 109, Figs. 37-41.

C. virgatula var. *luxurians* (J. Agardh) Rosenvinge 1909: 110. Collins 1911: 276.

C. virgatula f. *tenuissima* Collins In Collins, Holden, and Setchell 1900: 741.

Chromastrum virgatulum (Harvey) Papenfuss 1945: 323. Doty 1948: 264.

Kylinia virgatula (Harvey) Papenfuss 1947: 437. Hehre and Mathieson 1970: 206, 237. Mathieson et al. 1969: 132. Taylor 1957: 214.

K. virgatula f. *luxurians* (J. Agardh) Collins 1906: 194.

Hehre and Mathieson 1970: 206, 237. Taylor 1957: 214, pl. 31, Figs. 4-7.

Rhodochorton virgatulum (Harvey) Rosenvinge 1935: 7.

Trentepohlia virgatula (Harvey) Farlow 1881: 109, pl. X, Fig. 3. Collins 1888: 312; 1888a: 10. Martindale 1889: 100. Pike 1886: 109.

T. virgatula var. *secundata* (Lyngbye) Farlow 1881: 109. Pike 1886: 109.

Acrochaetium daviesii auct. non. (Dillwyn) Naegeli: Collins 1906: 194 (pro parte?).

Callithamnion daviesii auct. non. (Dillwyn) Lyngbye: Harvey 1853: 243.

Chantransia daviesii auct. non. (Dillwyn) Thuret In LeJolis: Collins 1880: 162 (pro parte?); 1894: 233 (pro parte?); 1900: 49 (pro parte?); 1911: 276 (pro parte?).

Trentepohlia daviesii auct. non. (Dillwyn) Pringsheim: Pringsheim 1862: 26, Taf VIII, Figs. 1-6.

Acrochaetium flexuosum auct. non. Vickers: Collins 1906: 192. Collins, Holden, and Setchell 1910: 1696. Taylor 1937: 233; 1957: 219.

Chantransia flexuosa auct. non. (Vickers) Collins: Collins 1911: 186.

Acrochaetium sagraeanum auct. non. (Montagne) Bornet: Boergesen 1915: 35 (pro parte). Bornet 1904: XXI (pro parte). Collins 1905: 231 (pro parte); 1906: 192 (pro parte). Hamel 1927: 77, 99 (pro parte); 1928: 173, 191 (pro parte). Hylander 1928: 159 (pro parte) Jao 1936: 244 (pro parte). Papenfuss 1945: 311 (pro parte). Taylor 1937: 233 (pro parte); 1957: 220 (pro parte); 1960: 309 (pro parte).

Chantransia sagraeana auct. non. (Montagne) DeToni: 1924: 51 (pro parte).

Plants epiphytic or epizoic, caespitose, up to 3 mm tall; original spore non-persistent. Prostrate system at first forming a small parenchymatous disc usually composed of a central cell and 3-4 peripheral cells; later proliferating in some plants to form a unistratose (rarely a partially bistratose) pseudoparenchymatous disc. Erect filaments sparsely

or moderately to freely and irregularly branched; laterals of variable length and some populations only 1-5 cells long. Cells cylindrical 8-15 (-20) μm wide and 15-100 μm long, L/D (1-) 2-6; each containing an axial or parietal stellate chromoplast and a central pyrenoid. Unicellular hairs up to 300 μm long abundant in some populations,, pseudolateral or terminating 1-3 celled lateral branches; sparse or absent in other populations.

Monosporangia ovoid, 10-20 μm wide and 15-26 (-32) μm long, solitary or in pairs, sessile or stalked, scattered on the erect filaments or sometimes densely crowded on short lateral branches.

Other reproductive structures not observed.

Type locality: Kvivig, Faeroes Islands (on "*Conferva rupestris*").

Holotype: C.

Distribution: Atlantic Coast of North America, Australia, Canary Islands, Europe, Sargasso Sea.

Hosts: A wide variety of algae and on hydroids.

Specimens examined:

CONNECTICUT: Black Rock Beacon (Long Island Sound), 20. VII. 1892, *Holden* (NY, Holden 646) New Haven, prior to 1853, *Hooper* (TCD). Woodmont, 27. VII. 1893, *Holden* (NY).

MAINE: Eagle Island (Penobscot Bay), 16. VII. 1905, *Collins* (NY). Fox Island, VIII. 1880, *Collins* (NY). Inner Mark Island, 8. VII. 1903, *Collins* (NY, PBA 1088). Kennebec River Mouth, VIII. 1880. *Booth* (NY). Peak's Island, IX. 1874, *Farlow* (FH).

MASSACHUSETTS: Eastham, 10. VII. 1907, *Collins* (NY). Falmouth (Cape Codder Point), 30. X. 1966, *Conway* et al. (NHA); 19. XI. 1969, *Woelkerling* (WJW 2237); 7. I. 1970, *Conway* (WJW 2294). Falmouth (Monauhant Beach), 12. III. 1969, *Conway* (WJW 1850); (WJW 1851). Falmouth (Waquoit Bay), 21. I. 1969, *Conway* (WJW 1842); 11. III. 1969, *Conway* (WJW 2273); 30. VI. 1969, *Conway* (WJW 2274); 7. VII. 1969, *Conway* (WJW 1845); 15. IX. 1969, *Conway* (WJW 1844); 1. X. 1969, *Conway* (WJW 1841). Gloucester (Niles Beach), IX. 1875, *Farlow* (FH); no date, *Farlow* (NY, Algae Exsic. Am. Bor. — Farlow, Anderson, and Eaton, No. 157). Hingham, prior to 1853, *Brewer* (TCD). Marblehead, 17. VI. 1902, *Collins* (NY). Mattapoisett, 30. V. 1905, *Collins* (NY); 20. X. 1906, Collins (NY, PBA 1393). Nantucket (Brauts Point), 16. VIII. 1898, *Collins* (NY). Nantucket (West Jetty, Nant. Center), 14. IV. 1970, *Woelkerling* (WJW 2476). Nantucket (?), prior to 1853, Durkee (TCD). New Bedford (Scontient Point),

13. VII. 1927, *Taylor* (NY). Penikese Island, 1. X. 1970. *Woelkerling* (WJW 2808). Sandwich (Cape Cod Canal Jetty), 7. IV. 1968, *Kastelowitz* (NHA); 13. X. 1970, *Woelkerling* (WJW 2816). West Falmouth (Harbor entrance), 10. XII. 1969, *Conway* (WJW 2131); 6. I. 1970, *Woelkerling* (WJW 2276). Woods Hole, VII. 1875, *Farlow* (FH); VII. 1903, Collins (NY); 10. VIII. 1947, *Abbott* (Abbott 1638); 3. VI. 1966, *Conway* (WJW 2168); 4. II. 1970, *Woelkerling* (WJW 2316); 2. VII. 1970, *Woelkerling* (WJW 2680); 29. I. 1971, *Woelkerling* (WJW 3299); 16. II. 1971, *Woelkerling* (WJW 3315).

NEW HAMPSHIRE: Fort Constitution, 20. IX. 1966, *Conway* and *Hehre* (NHA). Fox Point, 21. VII. 1966, *Conway* and *Shipman* (NHA). Great Boar's Head, 15. X. 1966, *Hehre* and *Conway* (NHA); 11. XII. 1966, *Hehre* and *Conway* (NHA). Little Boar's Head, 14. IX. 1966, *Hehre* (NHA); 25. XI. 1966, *Conway* and *Hehre* (NHA). Rye Ledge, 29. III. 1967 *Mathieson* and *Murphy* (NHA).

NEW JERSEY: Atlantic City, 16. IV. 1892, *Morse* (NY, No. 1696 in the Phycotheca Boreali Americana); 1. IX. 1925, *Rose* (NY).

NEW YORK: Cold Spring Harbor, 21. VII. 1893, Howe (?) (NY). Little Neck Bay (Long Island), 7. IV. 1966, *Keenan* (NHA).

RHODE ISLAND: Napatree Point, 9-11. X. 1872, *Eaton* (NY); (FH).

CALIFORNIA: San Pedro, XI. 1898, *Monk* (FH, type of *Chantransia virgatula* F. *tenuissima* Collins; ADU A32706, isotype; NY, isotype; WIS, isotype).

EUROPE: England (Torquay), prior to 1833, *Griffiths* (TCD, type of *Acrochaetium virgatulum* (Harvey) Bornet). Faeroes Islands (Kvivig), 19. VI. 1817, ? (C, Herb. Lyngbye, type). Sweden (Kattegat Channel), no date, ? (LD 35117, type of *Callithamnion luxurians* J. Agardh).

AUSTRALIA: Musselroe Bay (Tasmania), 7. II. 1948, *Levring* (ADU, A19846, isotype of *Acrochaetium subsimplex* Levring).

Colaconema secundata is distinguishable from other New England audouinelloid algae in 1) having spores germinating to form a distinctive, orbicular parenchymatous group of cells (Fig. 77) which later may proliferate (Figs. 80-81), and in 2) having distinctly stellate chromoplasts (Fig. 83), each with one pyrenoid, in cells of the erect filaments. In addition, most, but not all, New England populations possess a somewhat twiggy (virgate) habit as a result of having numerous 1-3 (-5) celled lateral branches terminated by unicellular hairs (Fig. 82).

Colaconema secundata occurs throughout the year in New England on a variety of algae or invertebrates in the sublittoral, and occasionally appears in the lower littoral,

particularly on *Porphyra*. It probably is found in greater numbers than any other audouinelloid alga in New England waters and most frequently is encountered as a dense fringe on blades of the sea grass *Zostera*.

Rosenvinge (1909) has provided an excellent account of this species (as *Chantransia virgatula*) and of the variation it exhibits; his concept of this species is recognized here (see also Hamel 1927, 1928). As noted previously (Woelkerling 1973, p. 96), the specific epithet "secundata" has nomenclatural priority over the specific epithet "virgatula". The form illustrated in this study (Fig. 82) is by far the most common in New England waters, although individuals of all forms discussed by Rosenvinge (1909) have been observed.

Most previous accounts (e.g. Hamel 1927, Kylin 1907, Rosenvinge 1909) state that the germinating spore divides to form a central cell and three surrounding cells. In all New England plants examined, four cells surround the central cell (Fig. 77); this difference, however, does not appear to be of any taxonomic consequence.

Some variation in the number of cell layers in the basal disc has also been reported. Hamel (1927), Kylin (1907), and Rosenvinge (1909) all record only single layered basal discs. Boergesen (1902) separates *Chantransia secundata* from *C. virgatula* on the basis that the former always has a two layered basal disc while the latter has only a single layered disc. Collins (1906) states that the basal discs are usually two layers thick; Taylor (1937, 1957) follows Boergesen (1902) in recognizing two species in his keys (Taylor 1937, p. 227; 1957, p. 211), but states in his descriptions (Taylor 1937, p. 230; 1957, p. 214) that the base is ". . . a multicellular disc 1-2 layers or more in thickness . . . ."

During this study, several discs (Fig. 80) that are partially two layered have been seen, but the majority are single layered. None of the sort illustrated by Boergesen (1902, p. 350, Fig. 51) or Taylor (1957, pl. 31, Fig. 3) have been encountered. It also appears evident that some

variation can occur in the number of layers in the base within single populations, and therefore, this variation has little taxonomic significance. Indeed, all plants examined in the type collections of *Colaconema secundata* and the other taxa here considered conspecific have single layered basal discs.

Only monosporangial plants have been observed during the present study; tetrasporangial individuals have, however, been reported in New England by Hehre and Mathieson (1970) and Taylor (1937, 1957). Kylin (1907, 1944) and Rosenvinge (1909), among others, have recorded them from Europe. Sexual stages remain unknown.

Collins in Collins, Holden, and Setchell (1900, No. 741) described and distributed *Chantransia virgatula* f. *tenuissima* based on a collection of Monks from San Pedro, California. Later Drew (1928, p. 170, pl. 38, Figs. 26, 27) raised the taxon to specific rank (as *Rhodochorton tenuissimum* (Collins) Drew), primarily on the bases of somewhat narrower filaments, lack of hairs, and sessile and not opposite sporangia.

The type collection of this species in FH as well as several isotypes (ADU, NY, WIS) have been examined and found to agree well with the types of *Colaconema secundata* and of *Callithamnion virgatulum*. Type collection plants of all three taxa have the same characteristic development of the basal disc, which in some cases have produced proliferations. The type plants of *Chantransia* f. *virgatula tenuissima* examined also possess (in contrast to what Drew (1928) found in her material) unicellular hairs and do have *some* stalked monosporangia and *some* sporangia in an opposite arrangement. In agreement with Drew, most sporangia are sessile and scattered. Drew reported a parietal chromoplast, but this was not evident in the type material examined. Since there appear to be no other reliable criteria of separation, *Chantransia virgatula* f. *tenuissima* and *Colaconema secundata* are considered here to be conspecific as was suspected earlier (Woelkerling 1971, p. 52).

Acrochaetium subsimplex Levring (1953, p. 473, Figs. 10A-D, 11) likewise is conspecific with *Colaconema secundata* (see Woelkerling 1971, p. 51).

A number of collections referred to *Audouinella daviesii* by Collins (see discussion under that taxon) have been examined and found to contain only (?) plants of *Colaconema secundata.* If one assumes that these collections do not contain a mixture of two taxa (such a mixture was not found during the present study), Collins' material has been misidentified and has been treated accordingly.

Likewise one collection (NY, Holden collection No. 646) hitherto referred to *Acrochaetium sagraeanum* (see Collins 1905, p. 231 and discussion of that taxon under "Species Excludendae") has been found to contain only plants of *Colaconema secundata;* the literature citations have been corrected accordingly.

Two collections in NY (one from Massachusetts and one from New Jersey, the latter being distributed as specimen 1696 in the Phycotheca Boreali Americana) hitherto referred to *Acrochaetium* (= *Chantransia*) *flexuosum* by Collins (1906, 1911), Collins, Holden, and Setchell (1910), and Taylor (1937, 1957) have been examined and found to contain only young plants of *Colaconema secundata.* Parenchymatous discs typical of young plants of *C. secundata* are abundant in both collections and in the largest plants these discs have become more or less obscured by subsequent cell division in prostrate system cells. Relatively few sporangia were present, but these fell within the range of dimensions found among other New England populations.

Specimens from Rhode Island referred by Taylor (1937, 1957) to *Acrochaetium flexuosum* have not been available for examination and their status therefore remains in doubt.

OTHER NEW ENGLAND RECORDS

In addition to the species already discussed, several other audouinelloid taxa have been reported from New

England waters. As a result of the present investigation, the occurrence of four of these taxa, discussed below under "Collections Inquirendae", is surrounded by doubt. The taxonomic status of two other taxa, discussed below under "Species Inquirendae", is open to question, and the type collection of a seventh taxon, discussed below under "Species Excludendae", has been referred to the Chlorophyta.

Collections Inquirendae

Acrochaetium attenuatum (Rosenvinge) Hamel 1927: 99; 1928: 192. Edelstein et al. 1970: 625. Jao 1936: 244, pl. 12, Fig. 1. Papenfuss 1945: 308. South 1970: 1. South and Cardinal 1970: 2079. Taylor 1937: 236, pl. 34, Fig. 1; 1957: 222, pl. 34, Fig. 1.

Chantransia attenuata Rosenvinge 1909: 106, Fig. 35. DeToni 1924: 56.

Rhodochorton attenuatum (Rosenvinge) Nakamura 1944: 103, Fig. 3.

For detailed morphological accounts of this taxon, see Nakamura (1944) and Rosenvinge (1909).

Type locality: Jelstrup, Limfjord, Denmark.

Type: C (Rosenvinge 3883).

Distribution: Northern Europe, Eastern Canada, Japan.

Hosts: A variety of algae.

Specimens examined: See below.

This taxon has been recorded once in New England by Jao (1936) from Norton Point, Martha's Vineyard, Massachusetts and subsequently reported by Taylor (1937, 1957). The collection upon which this record is based is apparently represented in MICH by a prepared slide bearing the number Woods Hole 280. (This same slide contains type collection specimens of two other taxa [*Acrochaetium radiatum* Jao and *A. microfilum* Jao] which are regarded here as conspecific with *Colaconema humilis* and *Audouinella microscopia* respectively).

The MICH slide has been examined during this study and found to contain two plants somewhat similar to those

described by Jao (1936), but the material was too fragmentary and too young to make any definite identification, although the specimens showed some features similar to young plants of *Audouinella saviana*. The taxonomic status of these plants therfore remains in doubt as does the occurrence of *A. attenuatum* in New England waters.

Likewise the record of Edelstein *et al.* (1970, p. 265) requires further investigation.

Audouinella efflorescens (J. Agardh) Papenfuss 1945: 326; 1947: 438. Edelstein and McLachlan 1968: 993, Figs. 1-2. Taylor 1957: 225.

Acrochaetium efflorescens (J. Agardh) Naegeli 1861: 405. Hamel 1927: 103; 1928: 196. Taylor 1937: 236.

Callithamnion efflorescens J. Agardh 1851: 15; 1876: 10.

Chantransia efflorescens (J. Agardh) Kjellman 1875: 14; 1883: 129. Kylin 1906: 113, Figs. 1-5; 1907: 119. Rosenvinge 1909: 134, Figs. 61-64.

Grania efflorescens (J. Agardh) Kylin 1944: 26, Fig. 24.

Rhodochorton efflorescens (J. Agardh) Drew 1928: 151. Rosenvinge 1935: 7.

For detailed morphological accounts of this taxon, see Kylin (1906) and Rosenvinge (1909).

Type locality: Kattegat Channel, Sweden.

Type: LD 35129.

Distribution: Arctic, Eastern Canada, Northern Europe.

Hosts: A variety of algae and invertebrates; also on rock.

Specimens examined: Sweden: Kattegat, 13. VIII. 1833, ? (LD 35129, type of *Callithamnion efflorescens* J. Agardh).

This taxon has been recorded (as *Chantransia efflorescens*) on *Rhodymenia* from Gay Head (Martha's Vineyard) Massachusetts by Farlow (1877, p. 245), but neither he nor anyone else apparently has made further reference to this collection. Moreover, no plants of *Audouinella efflorescens* from Gay Head on *Rhodymenia* could be located in FH or NY during this investigation, and this record of

the taxon in New England must therefore remain in doubt.

Farlow (1881, p. 109) also records a *Chantransia efflorescens* Thuret from Gay Head on *Cystoclonium*. Whether this is the same specimen as the one discussed above is uncertain, but plants from the *Cystoclonium* collection, the major portion of which is in FH (a fragment cut from the sheet is in the Collins material in NY), have been examined and found to contain sexual plants of *Audouinella daviesii* rather than specimens of *A. efflorescens*. Carposporophytes of the two are easily distinguishable because carospores are only terminal in *A. daviesii* but occur in rows of 2-3 in *A. efflorescens*. The notes of Taylor (1937, p. 236; 1957, p. 225) refer to Farlow's material on *Cystoclonium*, which is regarded here to belong to*A. daviesii* (q.v. for further comments).

Audouinella efflorescens is a distinctive species with its spirally twisted chromoplasts without pyrenoids and its seriate carpospores, and future study may show it to be a component of the New England flora. It apparently has recently been found in Nova Scotia (Edelstein and McLachlan 1968).

Audouinella spetsbergense (Kjellman) comb. nov. Figs. 61-63.

Rhodochorton spetsbergense (Kjellman) Kjellman 1883: 187. DeToni 1903: 1511.

Thamnidium spetsbergense Kjellman 1875: 31, Figs. 11-12.

Rhodochorton penicilliforme (Kjellman) Rosenvinge 1894: 66, Fig. 9; 1923-24: 388, Figs. 325-327. Boergesen 1902: 389, Fig. 60. Collins 1906a: 160. Drew 1928: 176. Edelstein et al. 1967: 200, Figs. 6, 28. Kylin 1907: 188; 1925: 44, Figs. 26a-c; 1944: 28. Taylor 1937: 239; 1957: 225.

Rhodochorton mesocarpum (Carm.) Kjellman var. *penicilliformis* (Kjellman) Kjellman 1883: 187, pl. 16, Figs. 6-7. Rosenvinge 1893: 792.

Thamnidium mesocarpum (Carm.) Kleen f. *penicilliformis* Kjellman 1875: 30; 1877: 25; 1877a: 23.

Plants epiphytic, caespitose, up to 2.0 mm tall; original

spore non-persistent. Prostrate system consisting of an irregularly discoid mass of pseudoparenchymatous filaments. Erect filaments sparingly to moderately and irregularly branched. Cells cylindrical, 8-13 μm wide and (10-) 20-35 (-50) μm long, L/D (1-) 1.5-4 (4.5); each cell containing a number of discoid to irregularly shaped chromoplasts without pyrenoids. Unicellular hairs not observed.

Tetrasporangia ovoid, 25-35 μm long and 16-25 μm wide, single or occasionally in pairs (rarely in groups of 3), sessile or on stalks, scattered over the erect filaments or occasionally terminal on lateral branches.

Other reproductive structures not observed.

Type locality: Fairhavn, Spitzbergen (79° 49′ N.).

Type: UPS.

Distribution: In North America, from Washington state northwards on the Pacific coast and Rhode Island northwards (?, see discussion) on the Atlantic Coast; also reported from northern Europe.

Hosts: Various algae and hydroids.

Specimens examined: SPITZBERGEN: Fairhavn Is. (79° 49′ N.), 19. VIII. 1872, *Kjellman* (UPS, type). Fairhavn Is. (79° 41′ N.), 12. VIII. 1872, *Kjellman* (UPS, type of R. *penicilliforme* (Kjellman) Rosenvinge).

This taxon has been recorded (as *Rhodochorton penicilliforme*) from Rhode Island (Collins 1906a, p. 160) and northern Massachusetts (Taylor 1937, p. 239; 1957, p. 225). Collins material has not been found either in FH or NY and the Massachusetts material has not been available for study. (The taxonomic description given above is based on data gathered from plants in the type collection; see Rosenvinge 1923-24 for a more complete account). Moreover, no additional plants of this taxon have been collected during the present investigation and three collections in NHA examined have been found to contain only plants of other species. Thus, the occurrence of this taxon in New England waters is open to question, and further investigation appears necessary. It has recently been reported from Nova Scotia (Edelstein et al. 1967), but did

not appear in a recent survey of Campobello Island, New Brunswick (Stone et al. 1970).

Kjellman (1875) described two new taxa from collections made on Fairhavn Island, Spitzbergen: *Thamnidium spetsbergense* Kjellman and *T. mesocarpum* (Carmichael) Kjellman forma *pencilliformis* Kjellman. The latter was given species status by Rosenvinge (1894, p. 66). The type specimens of both taxa, preserved on microscope slides in UPS, have been examined during this study and found to be identical in all respects including habit, cell dimensions, spore dimensions, and chromoplast morphology. Conseqently, they are here considered conspecific, with the specific epithet "spetsbergense" having nomenclatural priority. It has been referred to the genus *Audouinella* on the basis of Rosenvinge's (1923-24, p. 388, Fig. 27) record of spermatangia. Culture studies may show that *A. spetsbergense* has a diphasic life cycle similar to that of *A. purpurea* (see West. 1969).

The relationships of *A. spetsbergense* and *A. purpurea* require clarification. They differ from one another primarily in their habit (epibiotic vs. primarily saxicolous) and type of prostrate system (pseudo-parenchymatous vs. filamentous) and since none of the characters appear to be taxonomically reliable (see Woelkerling, 1971), the two entities may represent ecological variants of a single species. Because intermediate forms have not been found during this study, they are maintained as distinct taxa for the present.

Colaconema polyides (Rosenvinge) Woelkerling 1971: 19, Figs. 19, 27A.

Acrochaetium polyides (Rosenvinge) Boergesen 1915: 59. Kylin 1944: 26. Papenfuss 1945: 317.

Chantransia polyides Rosenvinge 1909: 132, Figs. 59-60. Levring 1935a: 460, Fig. 2.

For detailed morphological accounts of this taxon, see Rosenvinge (1909) and Woelkerling (1971).

Type locality: Tonneberg Banke, Denmark.

Type: C.

Distribution: Denmark, South Australia, Tasmania.

Hosts: Codium (Chlorophyta), *Polyides* (Rhodophyta).

Specimens examined: See below.

This taxon has been reported (as *Acrochaetium polyides*) from New Hampshire (Hehre and Mathieson 1970, p. 205) and Nova Scotia (Edelstein and McLachlan 1966, p. 38, Fig. 2; Edelstein et al. 1970, p. 625; South and Cardinal 1970, p. 2078), apparently in a sterile condition.

The New Hampshire collection and one Nova Scotia collection have been examined; in both cases the meagre amount of sterile Audouinella-like filaments present could not be identified to species with any certainty at all. The taxonomic affinity of these specimens and the occurrence of *A. polyides* in New England and Nova Scotia therefore remains doubtful. It seems likely that these collections have been referred to *A. polyides* solely on the basis of the type of host organism (see Edelstein and McLachlan 1969, p. 555), which, as noted above, is an unreliable criterion of systematic separation.

Species Inquirendae

Colaconema americana Jao 1936: 237, pl. 13, Fig. 8. Levring 1937: 94; 1953: 489. de Valera 1939: 3. Woelkerling 1971: 42.

Acrochaetium americanum (Jao) Papenfuss 1945: 312.

Type locality: Gay Head, Martha's Vineyard, Massachusetts.

Holotype: MICH, Woods Hole No. 272.

Distribution: Type locality; Southern Australia.

Hosts: Asparagopsis sp.

The type collection of this species has not been available for examination. Two other collections (WJW 2693, WJW 2699) of *Asparagopsis* containing an endophytic audouinelloid alga have been examined and referred to *Colaconema minima* because of overall morphological agreement with that taxon. The cell and spore dimensions of plants in these collections are somewhat smaller than those reported by Jao (1936) for the type collection of *C. americana* (Table

6), and no greatly swollen cells were found, thus placing further doubt (see Woelkerling 1971, p. 42) upon the taxonomic significance of that character. Moreover, the monospores of the collections examined may or may not rest in cup-like bases (Fig. 74), thus casting doubt upon the taxonomic validity of that character also. Upon re-examination, plants in the type collection of *C. americana* will almost certainly be found to be conspecific with *C. minima*.

The rather large number of audouinelloid taxa (including *Colaconema minima* and *C. americana*) whose thallus consists of a creeping prostrate system devoid of or bearing few celled erect filaments present more taxonomic problems and difficulties with identification than any other group within the complex. Such taxa have often been described on the basis of single collections of one or a few plants and have been distinguished on minor differences in cell or spore dimensions, spore arrangement, branching and other morphological characters whose systematic value is dubious (see Woelkerling 1971). Another whole series of such taxa are based on differences in the species of host organism (see Baardseth 1941, p. 46), and host specificity is likewise of doubtful taxonomic value (Woelkerling 1971, p. 11).

Until the type collections of all these audouinelloid algae can be critically compared and the taxa redefined (probably with considerable consolidation of present forms) on firmer morphological grounds, taxonomic procedure dictates a continued recognition of a rather large assemblage of poorly known and rather confusing entities.

Rhodochorton entozoicum (Reinsch In Giard) DeToni 1903: 1514.

Callithamnion entozoicum Reinsch In Giard 1890: 262.

Type locality: Massachusetts.

Type: BM.

Distribution: Apparently known only from the type locality.

Hosts: Marine invertebrates.

The type and only known New England collection of this

taxon has not been available for examination. Reinsch (1879) first described and illustrated material of this taxon from sponges and bryozoans, but as noted by Collins (1883), Reinsch never assigned a name to it. Giard (1890), however, formally described the taxon under the specific epithet of "entozoicum," and this was subsequently recorded by DeToni (1903).

A re-examination of the type collection will almost certainly show that *Rhodochorton entozoicum* is conspecific with *Colaconema membranaceum.* As noted by Collins (1883), DeToni (1903), and Giard (1890) himself, the two taxa are scarcely distinguishable from one another, and Hamel (1927, p. 59; 1928a, p. 152) regarded the two as conspecific. Hamel, however, gives no indication of having compared the type collections of the two taxa, and the present investigator prefers to defer final judgment until such a comparison can be made. Hamel also regards material of Giard (1890) from Wimeraux as belonging to *C. membranacea.*

Species Excludendae

Acrochaetium sagraeanum (Montagne) Bornet 1904: xxi = *Cladophora sagraena* Montagne 1856: 459.

Bornet (1904) united under the name of *Acrochaetium sagraeanum* specimens from Cuba (Montagne's type, which Bornet noted was sterile), Barbados (see Vickers 1905), California, and Connecticut (see Collins 1905). Later, Collins (1906) and Collins and Hervey (1917) referred specimens from Florida and Bermuda to this taxon.

Montagne's type has been re-examined during this study and found to belong to the Chlorophyta and probably to the genus *Cladophora* itself as originally suggested by Montagne (1856). The specimens have a distinctive green color, lack pit connections and do not possess monosporangia or other reproductive organs, all of which strongly militate against placing Montagne's plants in the *Audouinella* complex as suggested by Bornet.

New England plants referred to *Acrochaetium sagraea-*

num were originally collected by Holden (see Collins 1905, 1906) and are deposited in FH and/or NY. Four of these (Holden collection number 17,701 [= Collins, Holden and Setchell 1895: 39], 708 and 757) contain plants of *Audouinella saviana.* A fifth herbarium sheet (Holden collection number 646) contains plants of *Colaconema secundata.* The sixth collection cited by Collins (1905), Holden 750, could not be located, and its taxonomic status remains in doubt.

Plants in PC from California (which may represent fragments of UC 93071 or UC 789916 deposited at Berkeley) referred by Bornet to *Acrochaetium sagraeanum* have been examined and are referred here to *Audouinella daviesii.* Likewise plants from Barbados (Bornet 1904, Vickers 1905) are referred here to *A. daviesii.* Specimens from Bermuda (Collins and Hervey 1917); Collins, Holden and Setchell 1917, No. 2181), however, belong to *A. saviana.*

Collins (1906, p. 192) cites a collection of *Acrochaetium sagraeanum* from Florida, but no specimens could be located in FH or NY, and its status remains uncertain.

A number of literature references relating to one or more of the above collections can now be clarified. The name *Acrochaetium sagraeanum* (Montagne) Bornet as used by Boergeson (1915, p. 35), Collins (1906, p. 192), Hamel (1927, pp. 77, 99, Fig. 46; 1928, pp. 171, 193, Fig. 46), Jao (1936, p. 244), and Papenfuss (1945, p. 311) refers to the entire assemblage of collections described by Bornet (1904, p. XXI). DeToni (1924, p. 51) employed the name *Chantransia sagraeana* (Montagne) DeToni for Bornet's assemblage. The collection upon which Hamel (1927, 1928) based his illustrations has not been determined.

Vickers (1905, p. 60) relates to the Barbados collection while Collins (1905, p. 231), Collins, Holden and Setchell (1895, No. 39), Hylander (1928, pp. 158, 159), and Taylor (1937, p. 233; 1957, p. 220) pertain to the Connecticut material. The Bermuda collections are cited in Collins and Hervey (1917, p. 97) and Collins, Holden and Setchell (1917, No. 2181), Taylor (1960, p. 309) includes both the

Bermuda and Barbados collections. Corrected citations for these literature references have been listed under the synonomy of *Audouinella daviesii, A. saviana,* and *Colaconema secundata.*

EASTERN CANADIAN AND ARCTIC RECORDS

According to South and Cardinal (1970), 28 species of audouinelloid algae have been recorded from the eastern Canadian coast from Cape Chidley, Labrador southwards to the New Brunswick-Maine border.

In addition to those taxa listed from eastern Canada and the Arctic in the descriptive catalogues of Taylor (1937, 1957), seven other taxa have been reported in this region, chiefly as a result of the Nova Scotia studies of Edelstein and McLachlan (1966, 1968, 1969) and of Edelstein et al. (1967, 1970). These include *Acrochaetium bornetii* Papenfuss, *A. endozoicum* (Darbishire) Batters, *A. inclusum* (Levring) Papenfuss, *A. kylinii* Hamel, *A. ralfsiae* Boergesen, *A. subtilissimum* (Kuetzing) Hamel, and *Kylinia cytophaga* (Rosenvinge) Kylin.

A number of these records appear highly questionable. Thus, for example, Edelstein and McLachlan (1969, p. 558) record *Acrochaetium kylinii, A. ralfsiae,* and *A. subtilissimum* from Nova Scotia (the only records for this region) on the basis of some endophytic portions of sterile specimens with the comment ". . . we regard these species as preliminary records only." Other records of similar merit also occur (e.g. the Canadian record for *A. polyides* [Edelstein and McLachlan 1966, p. 38] apparently is based on sterile material), and in other cases taxa have been identified on the basis of type of host organism (Edelstein and McLachlan 1969, p. 555) or similar criteria which are of dubious taxonomic significance.

Until all of the specimens involved in publication records for the Cape Chidley, Labrador to New Brunswich-Maine border region can be critically re-examined along with other available material from the area (a task beyond the

scope of the present paper), the number and distribution of audouinelloid algae along these coasts must necessarily remain uncertain. South and Cardinal (1970, p. 2079, footnote 3) also state that many of the species require further investigation.

Only scattered records of audouinelloid algae north of Cape Chidley, Labrador have appeared in the literature and most of these are summarized in the papers of Kjellman (1883) and Lund (1959) and the catalogues of Taylor (1937, 1957). Until relevant herbarium specimens and additional field collections become available for study, the nature and distribution of audouinelloid algae in arctic regions will likewise remain uncertain.

SUMMARY

The systematics, morphology, ecology, and distribution of marine representatives of the *Audouinella* complex (Acrochaetiaceae, Rhodophyta) in New England waters (including New York and New Jersey) have been studied. These investigations support the taxonomic proposals of Woelkerling (1971) and have resulted in the recognition of two genera and eleven species to occur definitely in this region. Seven species, known to reproduce sexually are referred to *Audouinella;* the form genus *Colaconema* contains four New England representatives which are unknown in the sexual state.

A number of published records based on misidentifications have been corrected and in one instance, the type specimen of a taxon [*Acrochaetium sagraeanum* (Montague) Bornet] has been excluded from the Rhodophyta. Records of questionable occurence, taxa whose status is in doubt, and the state of knowledge of marine audouinelloid algae in eastern Canada and the Arctic are considered briefly.

ACKNOWLEDGMENTS

Sincere thanks are due the curators of the algal collec-

tions housed at the following institutions for the loaning of relevant herbarium specimens: Atlantic Regional Laboratory, Halifax, Nova Scotia; the Botanical Museum and Herbarium, Copenhagen; the Botanical Museum, Lund; the Farlow Herbarium, Harvard University; the Herbarium Universitatis Florentinae, Firenze, Italy; the Institute of Systematic Botany, University of Uppsala; the National Museum of Canada; the National Museum of Wales, Cardiff, U.K.; the New York Botanical Gardens; the Museum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris; the Rijksherbarium, Leiden, Netherlands; Rutgers University; Trinity College, Dublin, Ireland; the University of Adelaide; the University of California; the University of Hawaii; the University of Michigan; and the University of New Hampshire.

Thanks are also due to Dr. I. A. Abbott, Dr. E. J. Hehre, and Mr. R. Stone for the loan of specimens in their personal herbaria, to Miss Joan Conway for collecting several specimens, and to Dr. R. T. Wilce and Dr. M. R. Carriker for arranging for use of facilities at the Marine Biological Laboratory in Woods Hole.

This work was supported in part by National Science Foundation Grant GB-13250 to the Marine Biological Laboratory, Woods Hole, Massachusetts. Publication costs have been defrayed by the Norman C. Fassett Memorial Fund.

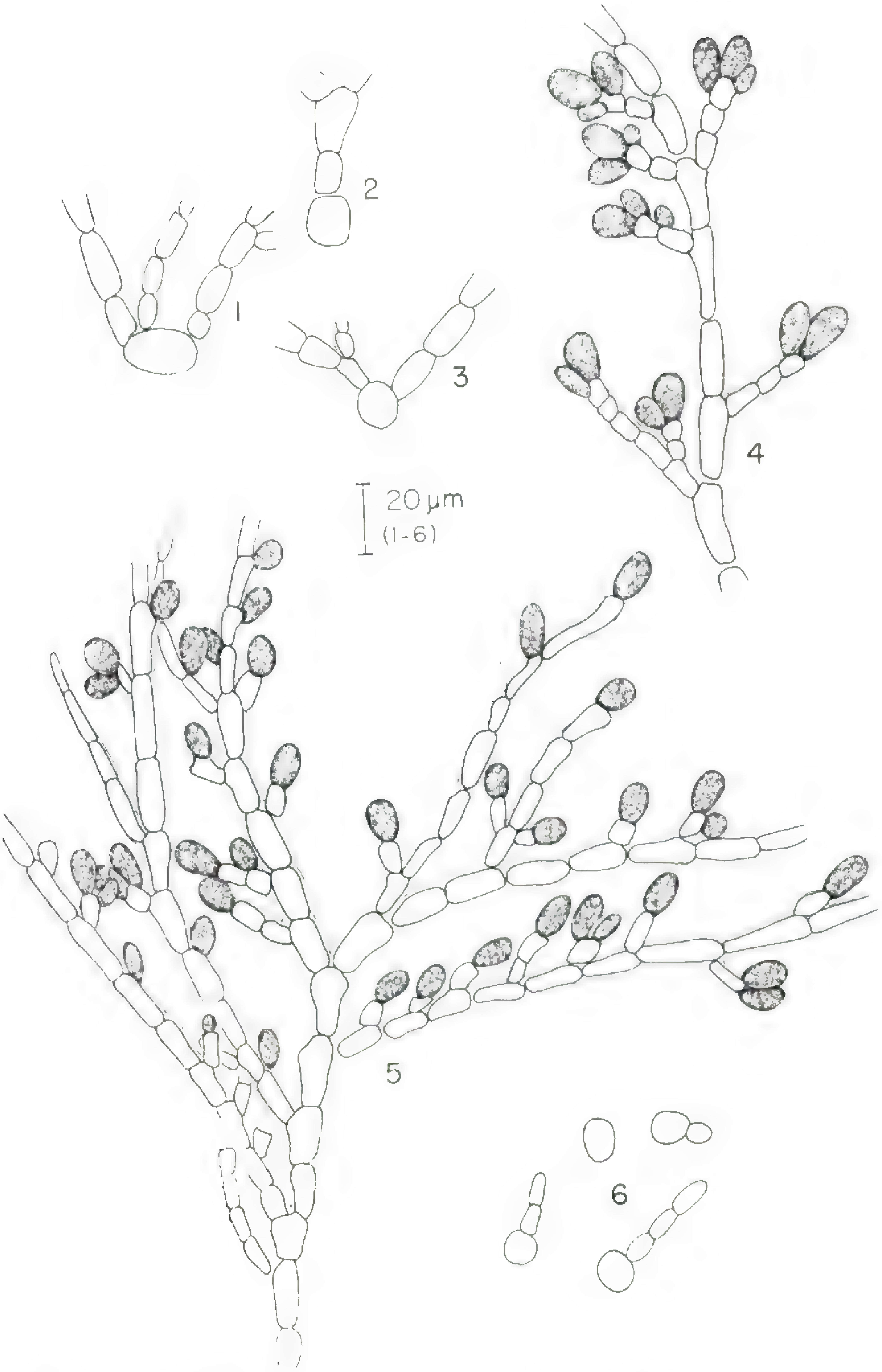
ADDENDUM

After this article had gone to press, Professor Peter S. Dixon provided me (personal communication) with some additional information about the typification of *Audouinella daviesii* and *A. thuretii*.

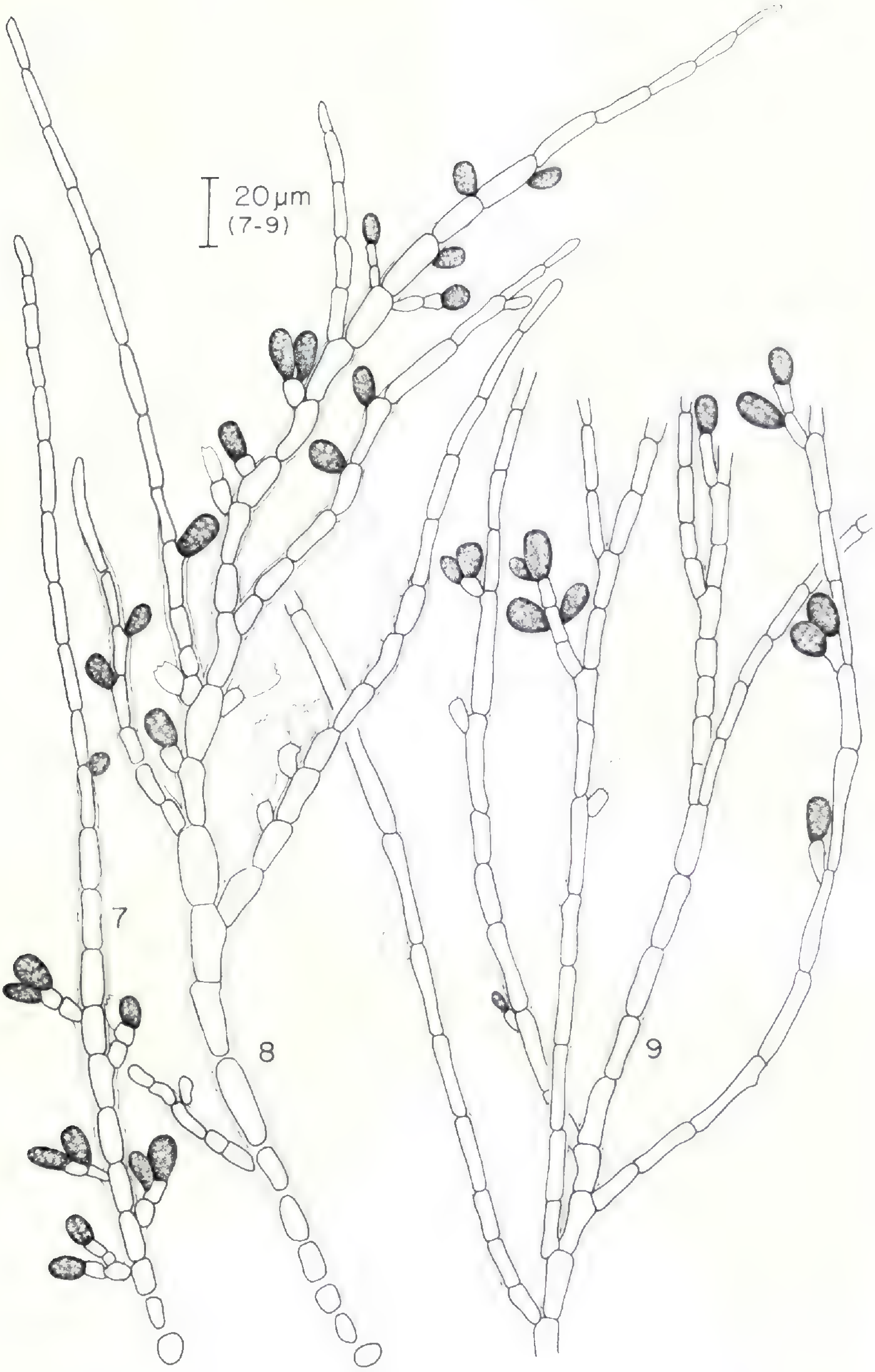
According to Professor Dixon, the only specimen of *Conferva daviesii* in the Dillwyn collections at NMW comes from Swansea rather than from Bantry Bay, the type locality given by Dillwyn. A fragment of the NMW collection was sent to me on loan, and an examination of it indicated that it was material of *C. daviesii*. However, since this specimen apparently does not come from Bantry Bay, it

can at best be regarded only as authentic material rather than type material and the statements in the body of this paper should be modified accordingly.

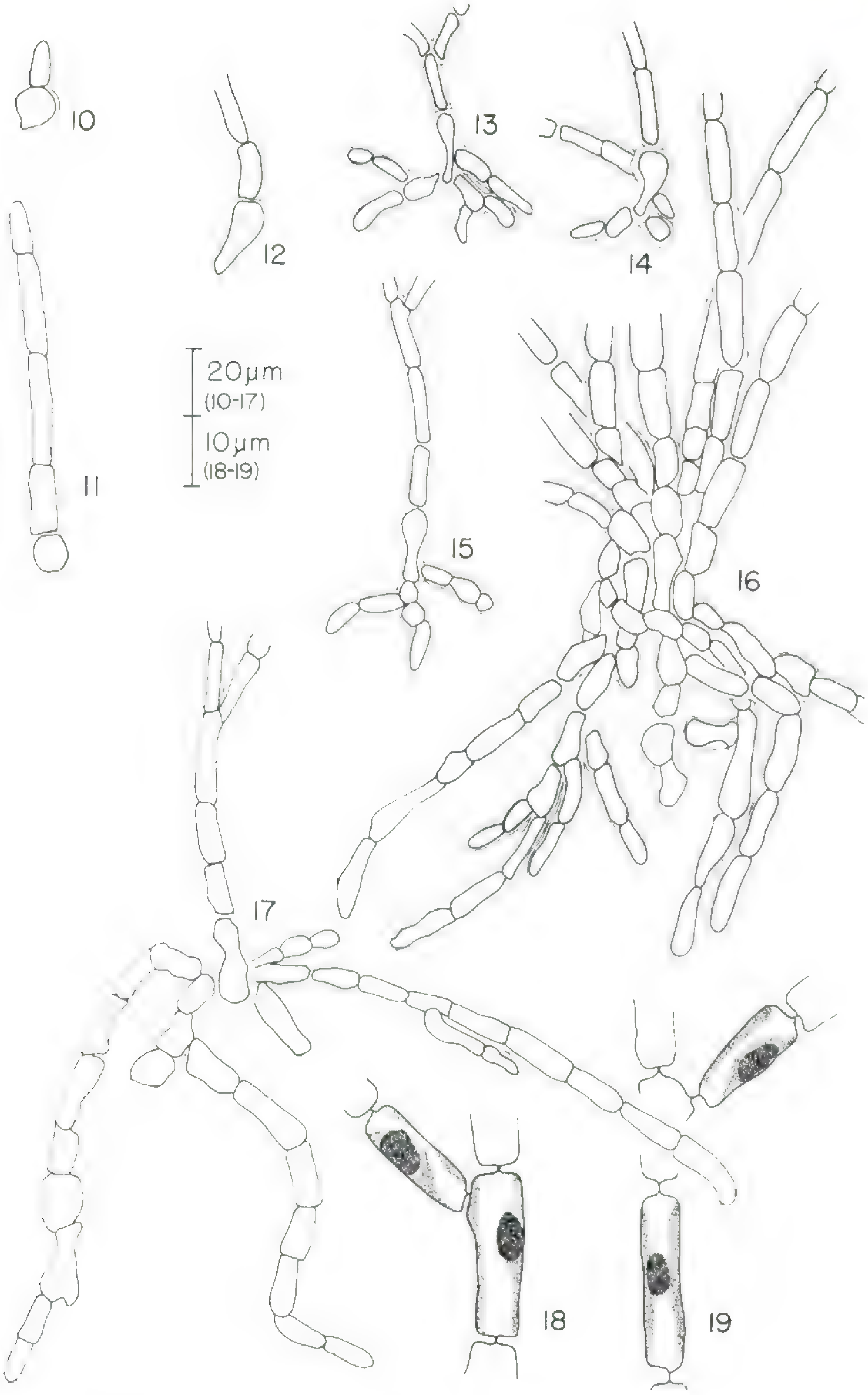
Professor Dixon also informed me that the type material of *Audouinella thuretii* should be dated 5. IX. 1853 (see Bornet 1904), but that the earliest material he could find in PC is dated 1. IX. 1856. Portions of the latter collection have been examined during this study. Until the matter of the dates is further clarified, the 1856 material should be regarded as authentic rather than type, and statements in the body of this paper should be modified accordingly.



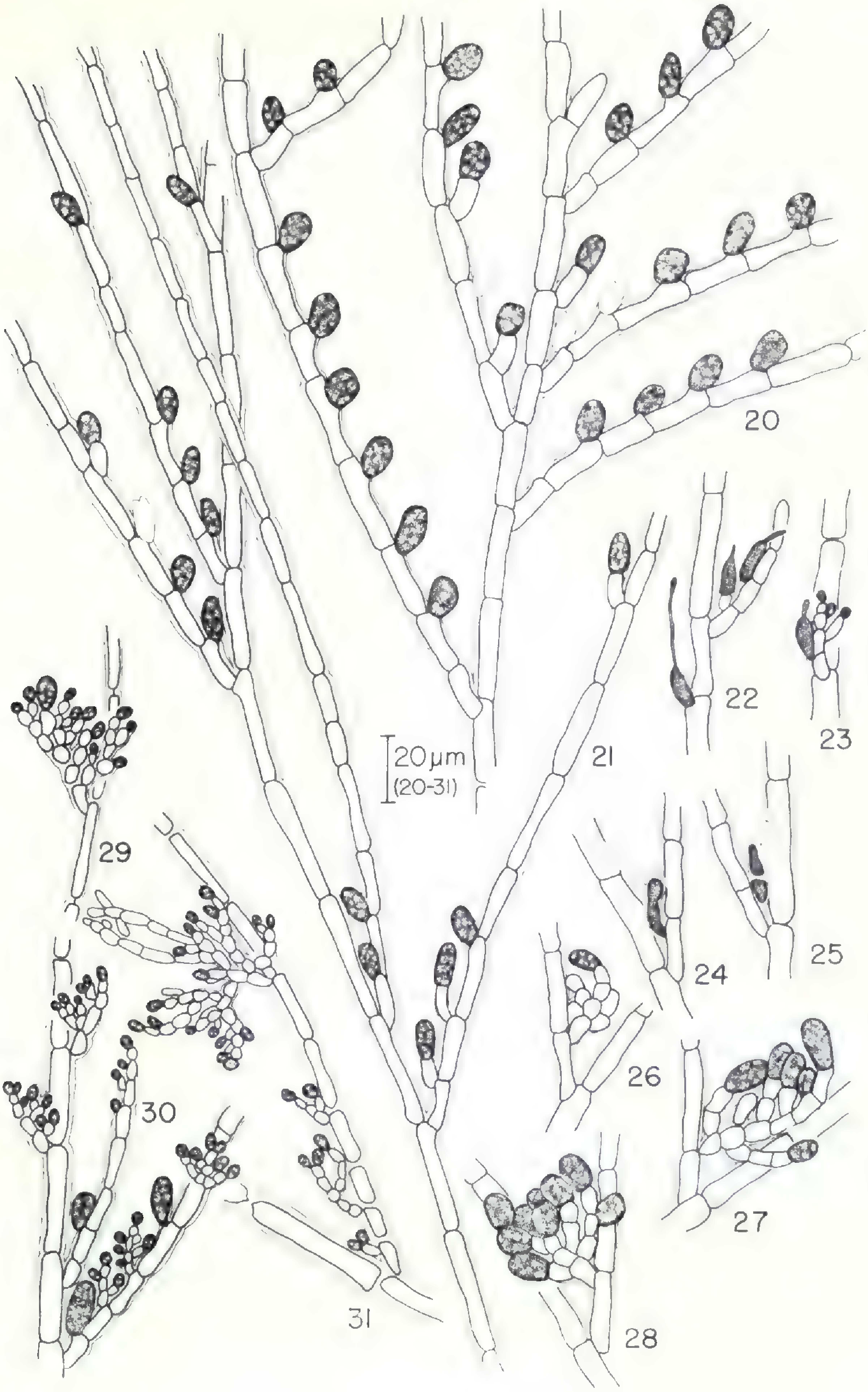
Figs. 1-6. *Audouinella alariae* (Jonsson) Woelk. Figs. 1-3. Unicellular bases bearing a variable number of erect filaments. Figs. 4-5. Portions of densely branched erect filaments with numerous monosporangia. Fig. 6. Sporelings. Figs. 1 3, 4: NY (Hardhead Island, Penobscot Bay, Maine, VII. 1894, *Collins* [= Collins, Holden, and Setchell 1896a: 236]); Fig. 2: NY (Hampton, New Hampshire, VII. 1894, *Collins*); Fig. 5: WJW 2275 (Nubble Light, Maine, 19. VIII. 1969, *Hehre*); Fig. 6: FH (Casco Bay, Maine, VII. 1939, *Weatherill*).



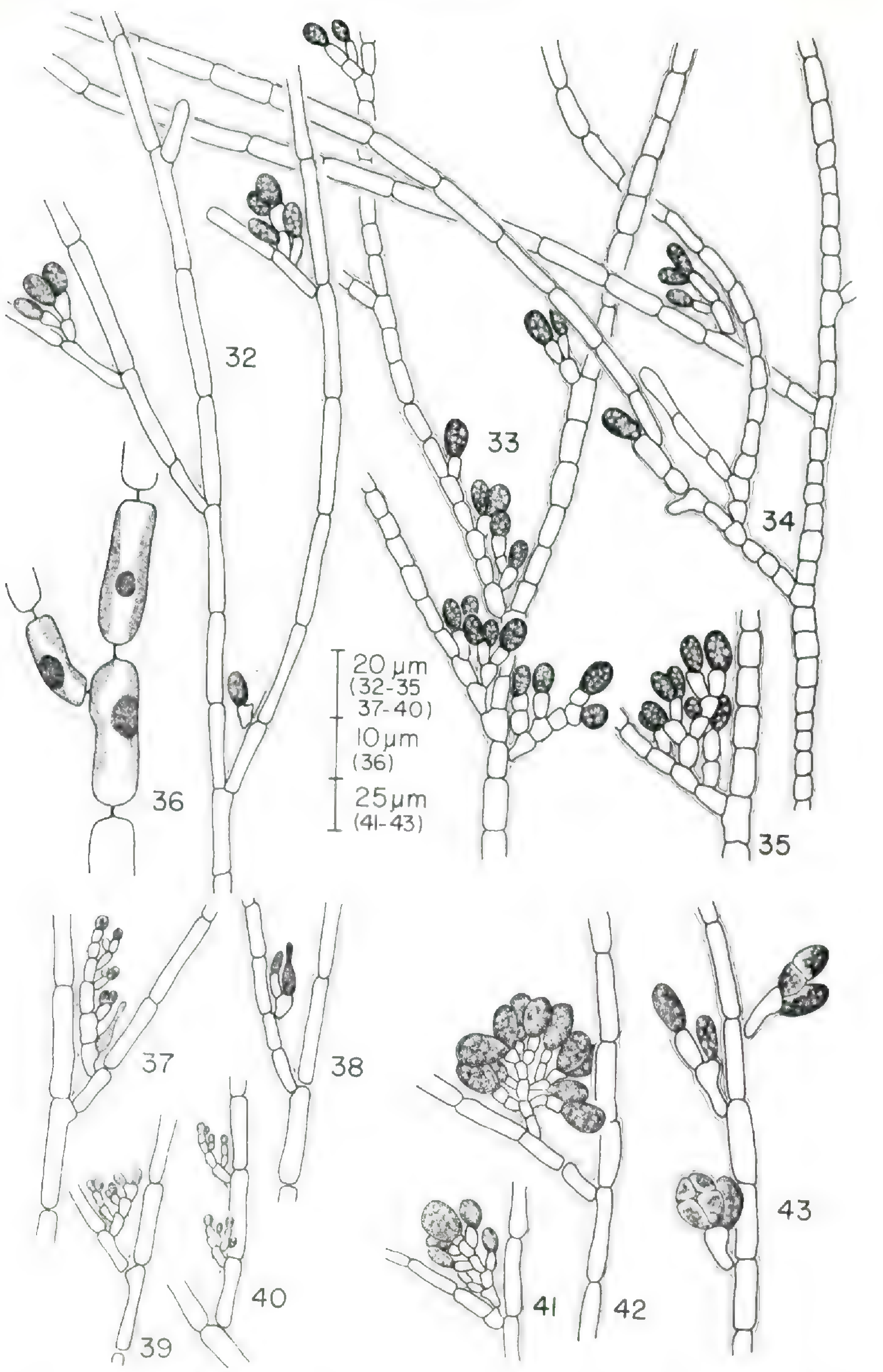
Figs. 7-9. *Audouinella alariae* (Jonsson) Woelk. Figs. 7-8. Habits of fairly small plants with mature monosporangia. Fig. 9. Portion of sparsely branched erect system with scattered monosporangia. Fig. 7: NY (Hardhead Island, Penobscot Bay, Maine, VII. 1894, *Collins* [= Collins, Holden, and Setchell 1896a: 236]); Figs. 8, 9: WJW 2275 (Nubble Light, Maine, 19. VIII. 1969, *Hehre*).



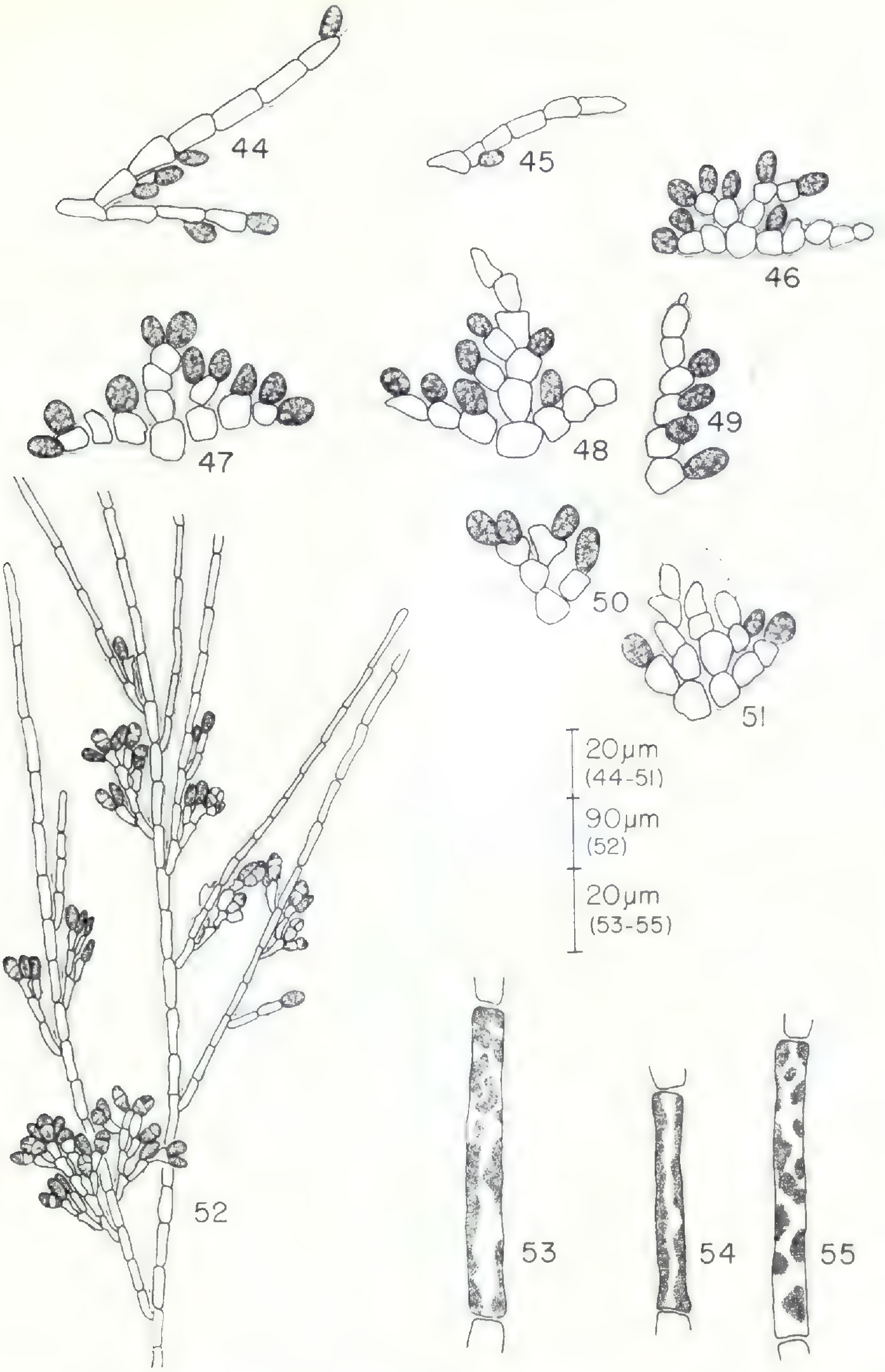
Figs. 10-19. *Audouinella dasyae* (Collins) Woelk. Figs. 10-12. Sporelings. Figs. 14-17. Variation in structure of prostrate system. Note central panduriform to pryriform cell which may become obscured in robust specimens (Fig. 16). Figs. 18-19. Chromoplasts in cells of erect filaments. Figs. 10-12: WJW 2853 (Old Silver Beach, West Falmouth, Massachusetts, 31. X. 1970, *Woelkerling*); Figs. 13, 14: Edelstein 2563 (Malpeque Bay, Prince Edward Island, 5. VIII. 1966, *Edelstein*); Figs. 15, 18, 19: WJW 3311 (Woods Hole, Massachusetts, 16. II. 1971, *Woelkerling*); Fig. 16: WJW 2977 (Old Silver Beach, West Falmouth, Massachusetts, 30. XII. 1970, *Woelkerling*); Fig. 17: WJW 2534 (Waquoit Bay [Harbor Entrance], Falmouth, Massachusetts, 27. IV. 1970, *Woelkerling*).



Figs. 20-31. *Audouinella dasyae* (Collins) Woelk. Figs. 20-21. Filaments of erect system with monosporangia. Figs. 22-23. Unfertilized carpogonia. Figs. 24-25. Fertilized carpogonia. Note transverse division (Fig. 25). Figs. 26-28. Stages in development of carposporophyte. Figs. 29-31. Spermatangia. Note varying arrangement. Fig. 20: WJW 3311 (Woods Hole, Massachusetts, 16. II. 1971, *Woelkerling*); Fig. 21: WJW 2820 (Woods Hole, Massachusetts, 13. X. 1970, *Woelkerling*); Figs. 22-23: FH (North Eastham, Massachusetts, 9. VIII. 1959, *Lamb* A-174 [filed under the host, *Dasya pedicellata*]); Figs. 24-28, 30: WJW 1852 (West Yarmouth, Massachusetts, 3. X. 1969, *Woelkerling*); Figs. 29, 31: WJW 2249 (West Yarmouth, Massachusetts, 16. XI. 1969, *Woelkerling*).



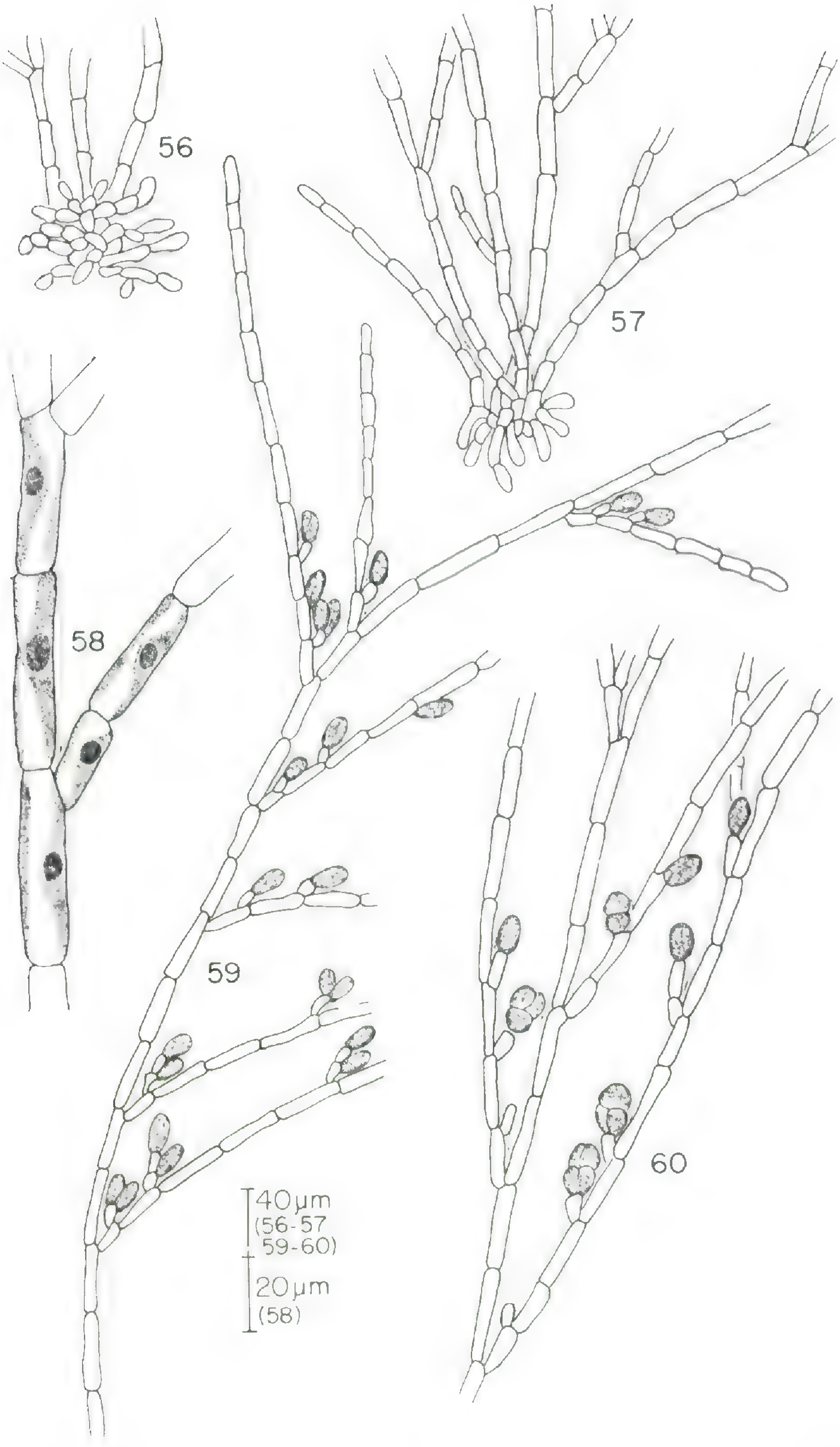
Figs. 32-43. *Audouinella daviesii* (Dillwyn) Woelk. Figs. 32-35. Filaments of erect system bearing monosporangia. Note clustered arrangement of sporangia and variation in cell size. Fig. 36. Chromoplasts in cells of erect filaments. Figs. 37-40. Spermatangia and unfertilized carpogonia. Figs. 41-42. Stages in carposporophyte development. Fig. 43. Tetrasporangia. Fig. 32: WJW 2719 (Woods Hole, Massachusetts, 17. VII. 1970, *Woelkerling*); Fig. 33: WJW 2978 (Old Silver Beach, West Falmouth, Massachusetts, 30. XII. 1970, *Woelkerling*); Fig. 34: WJW 2536 (Waquoit Harbor, Falmouth, Massachusetts, 27. IV. 1970, *Woelkerling*); Fig. 35: WJW 3302 (Woods Hole, Massachusetts, 29. I. 1971, *Woelkerling*); Fig. 36: WJW 2332 (Woods Hole, Massachusetts, 4. II. 1970, *Woelkerling*); Figs. 37-42: WJW 2678 (Woods Hole, Massachusetts, 2. VII. 1970, *Woelkerling*); Fig. 43: WJW 2198 (Montauk Point, New York, 20. I. 1970, *Woelkerling*).



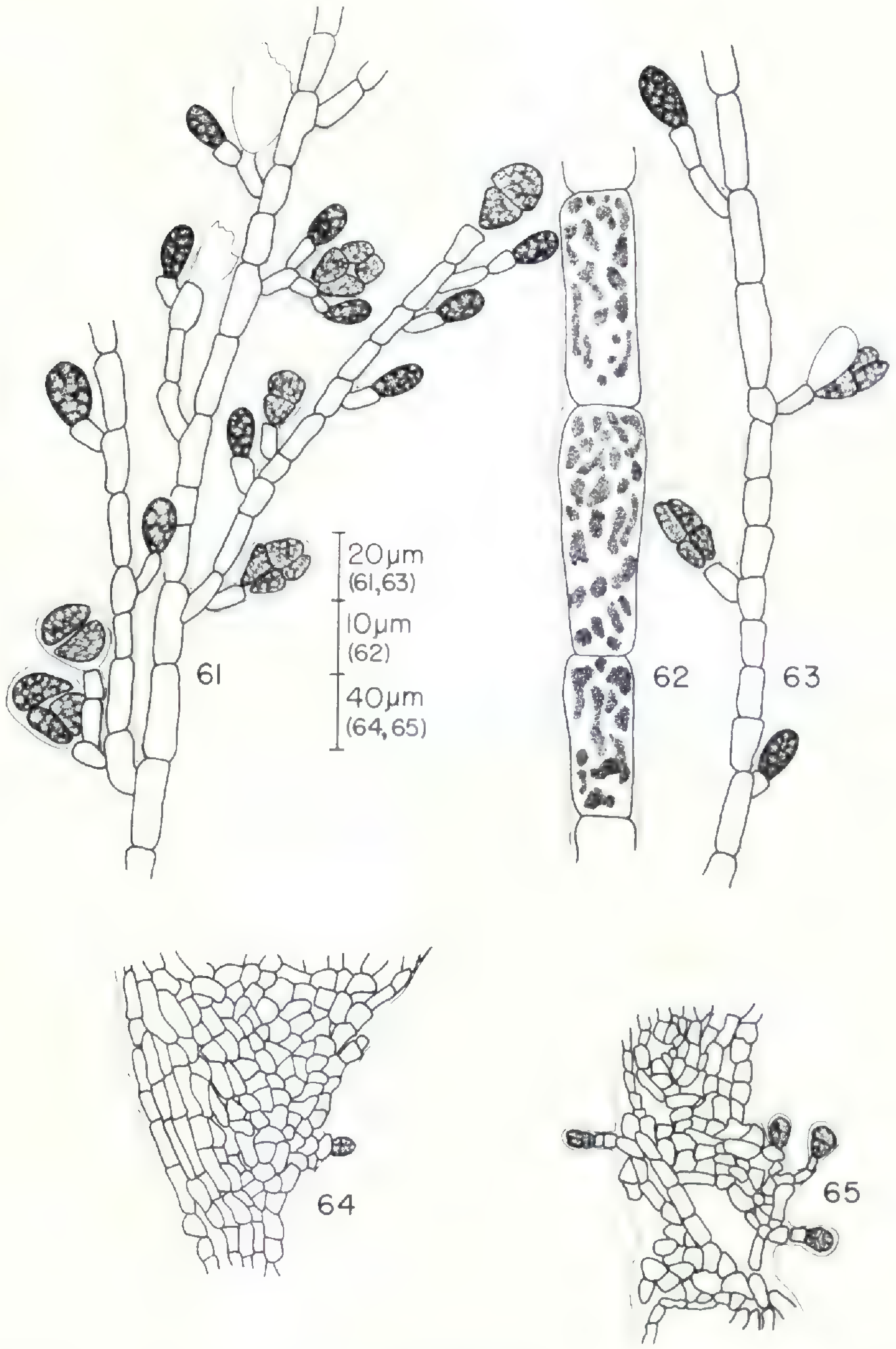
Figs. 44-45. *Audouinella unifila* (Jao) Woelk. Habit of two plants. MICH (Norton Point, Martha's Vineyard, 3. VIII. 1934, *Jao*, holotype).

Figs. 46-51. *Audouinella microscopica* (Naegeli In Kuetzing) Woelk. Habit of monosporangial plants. Figs. 46-47: MICH (Norton Point, Martha's Vineyard, 3. VIII. 1934, *Jao*, type of *Acrochaetium microfilum* Jao); Figs. 48-51: MICH (Black Rock, Sconticut Neck, New Bedford, Massachusetts, 25. VII. 1934, *Jao*, type of *Acrochaetium compactum* Jao).

Figs. 52-55: *Audouinella purpurea* (Lightfoot) Woelk. Fig. 52 Portion of erect system bearing carposporophytes. Figs. 53-55. Chromoplasts in cells of erect filaments. Figs. 52-55. WJW 3297 (Sandwich, Massachusetts, 22. I. 1971, *Woelkerling*).

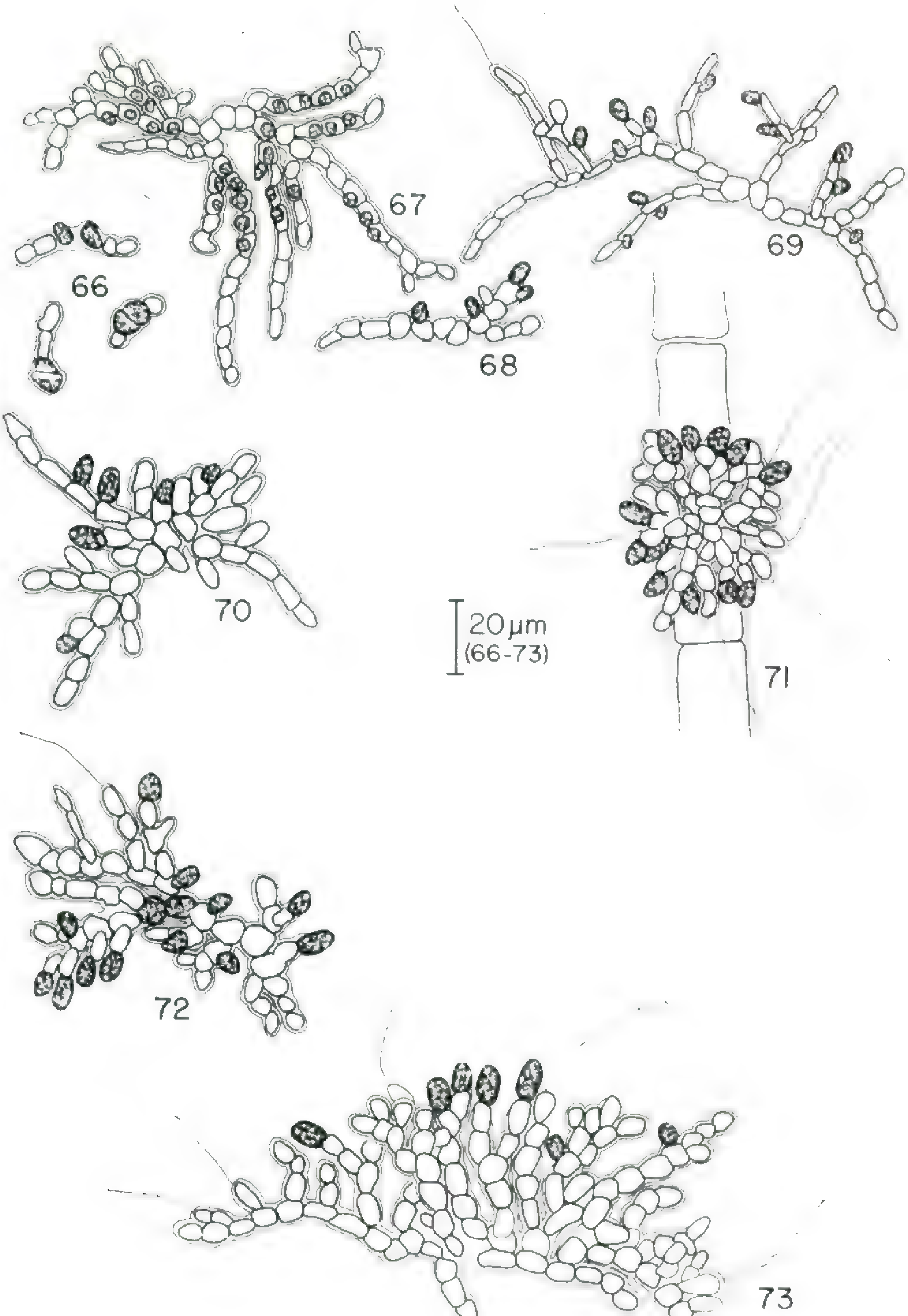


Figs. 56-60. *Audouinella saviana* (Meneghini) Woelk. Figs. 56-57. Prostrate systems. Fig. 58. Chromoplasts in cells of erect filaments. Figs. 59-60. Erect filaments bearing monosporangia (Fig. 59) and tetrasporangia (Fig. 60). Figs. 56-59: WJW 2753 (Woods Hole, Massachusetts, 21. VII. 1970, *Wilce*); Fig. 60: WJW 3818 (Sandwich, Massachusetts , 13. X. 1970, *Woelkerling*).

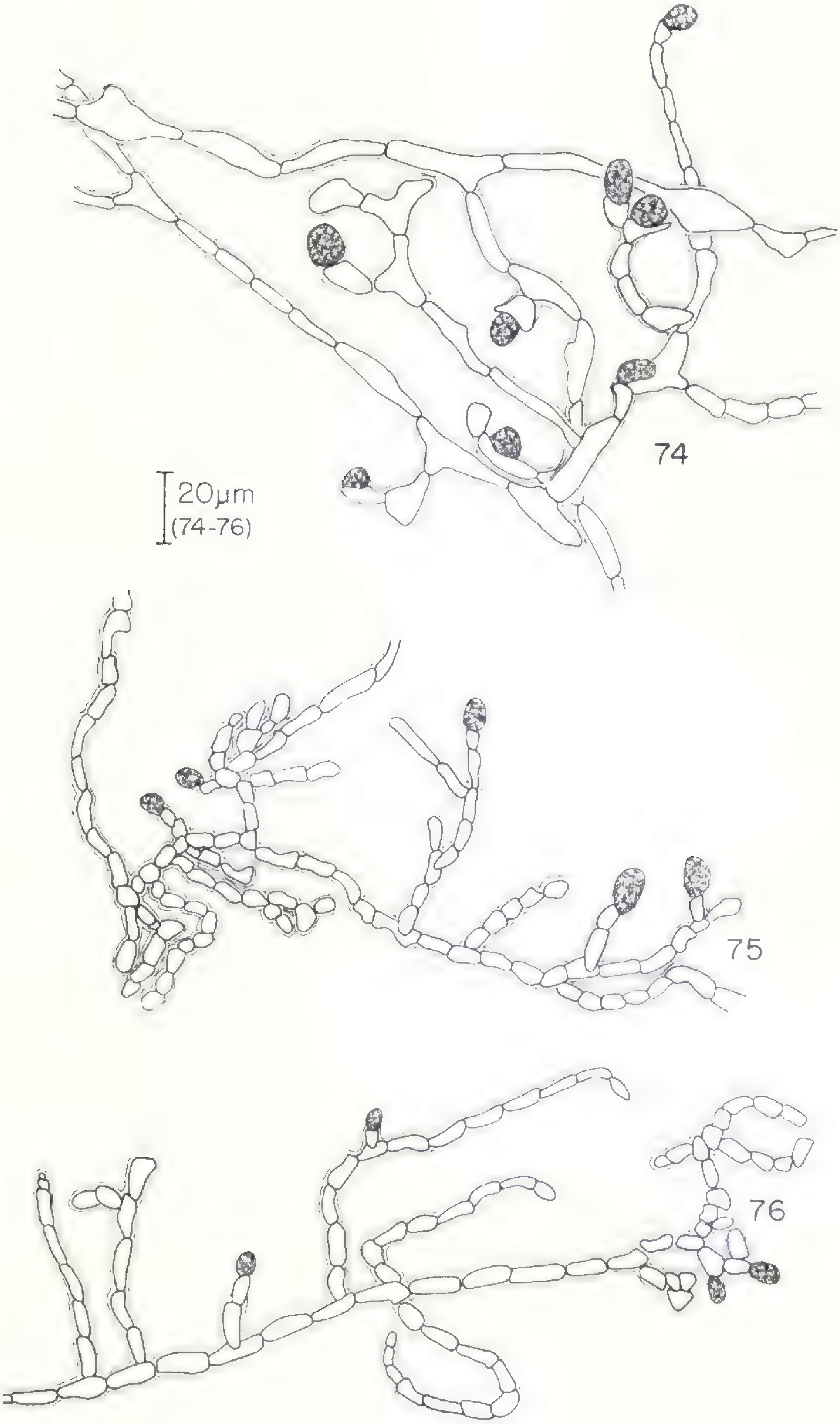


Figs. 61-63. *Audouinella spetsbergense* (Kjellman) Woelk. Figs. 61, 63. Erect filaments bearing tetrasporangia. Fig. 62. Chromoplasts in cells of erect filaments. Fig. 61: UPS (Fairhavn Island, Spitzbergen, 19. VIII. 1872, *Kjellman*, type of *A. spetsbergense*); Figs. 62, 63: UPS (Fairhavn Island, Spitzbergen, 12. VIII. 1872, *Kjellman*, type of *Rhodochorton penecilliforme*).

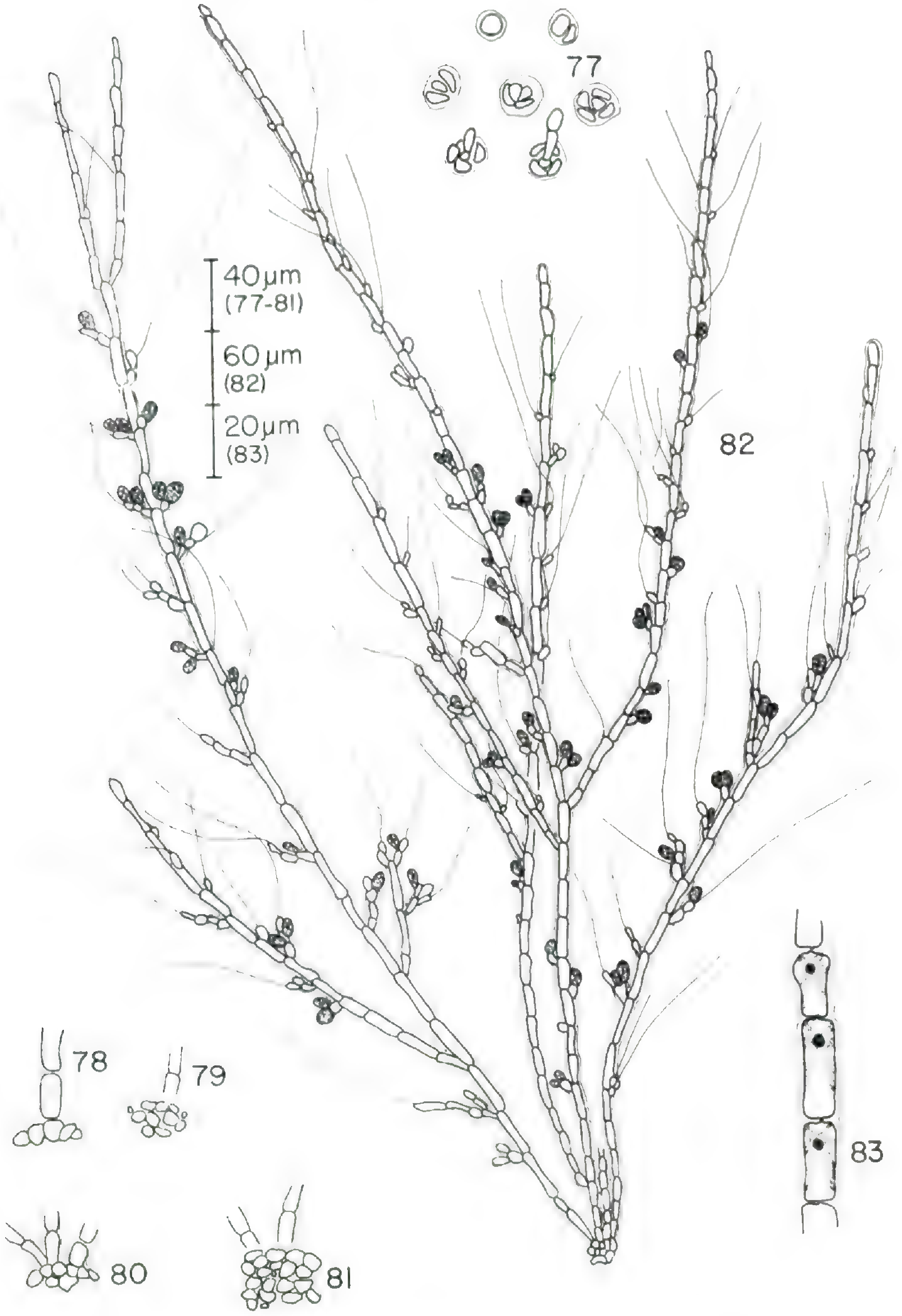
Figs. 64-65. *Caloconema membranacea* (Magnus) Woelk. Habit of portions of two plants. Note tetrasporangia (Fig. 65). Figs. 64-65: FH (Revere Beach, Massachusetts, 29. V. 1886, *Collins*, from Hauck and Richter 1888: 154).



Figs. 66-73. *Colaconema humilis* (Rosenvinge) Woelk. Fig. 66. Sporelings. Figs. 67-73. Habit of monosporangial plants. Figs. 66-69: MICH (Norton Point, Martha's Vineyard, Massachusetts, 3. VII. 1934, *Jao*, type of *Acrochaetium radiatum* Jao); Figs. 70, 72, 73: Edelstein 1382 (Ketch Harbor, Nova Scotia, 31. V. 1965, *Edelstein*); Fig. 71: WJW 1838 (Woods Hole, Massachusetts, 26. VI. 1969, *Conway*).



Figs. 74-76. *Colaconema minima* (Collins) Woelk. Habit of monosporangial plants. Note variation in shape of monosporangia and in cells subtending them. Fig. 74: WJW 2699 (Sandwich, Massachusetts, 30. VI. 1970, *Woelkerling*); Fig. 75: FH (Robinson's Hole, Elizabeth Islands, Massachusetts, VIII. 1907, *Collins*, type [= Collins, Holden, and Setchell 1908: 1493]); Fig. 76: C (Mollegrund, Denmark, 8. VIII. 1899, *Rosenvinge*, type of *Chantransia emergens* Rosenvinge).



Figs. 77-83. *Colaconema secundata* (Lyngbye) Woelk. Fig. 77. Sporelings showing characteristic parenchymatous grouping of cells. Figs. 78-81. Prostrate system of mature plants. Fig. 82. Habit of virgate plant. Fig. 83. Chromoplasts in cells of erect filaments. Fig. 77: WJW 2316 (Woods Hole, Massachusetts, 4. II. 1970, *Woelkerling*); Figs. 78-79, 82: WJW 2276 (West Falmouth, Massachusetts, 6. I. 1970, *Woelkerling*); Figs. 80-81: WJW 2476 (Nantucket Center, Massachusetts, 14. IV. 1970, *Woelkerling*); Fig. 83: WJW 2808 (Penikese Island, Massachusetts, 1. X. 1970, *Woelkerling*).

Table 1. Present status of audouinelloid taxa listed by Giard (1890), Hehre and Mathieson (1970), and Taylor (1957), (Author citations for taxa are recorded in the taxonomic treatments.)

Name of Taxon in Older Literature	*Present Status*
Acrochaetium alcyonidae	Conspecific with *Audouinella daviesii*
A. amphiroae	Conspecific with *A. daviesii*
A. attenuatum	See "Collections Inquirendae"
A. dasyae	*Audouinella dasyae*
A. daviesii	*Audouinella daviesii*
A. emergens	Conspecific with *Colaconema minima*
A. flexuosum	All New England collections referred to *Colaconema secundata*
A. intermedium	Conspecific with *Audouinella dasyae*
A. microfilum	Conspecific with *Audouinella microscopica*
A. minimum	*Colaconema minima*
A. polyides	See "Collections Inquirendae"
A. radiatum	Conspecific with *Colaconema humilis*
A. sagraeanum	See "Species Excludendae"
A. thuretii	Conspecific with *Audouinella saviana*
A. zosterae	Conspecific with *Audouinella dasyae*

Table 1 — Continued

Audouinella efflorescens	See "Collections Inquirendae"
A. membranacea	*Colaconema membranacea*
Colaconema americana	See "Species Inquirendae"
Conchocelis rosea	Referred to Bangiophycidae; not discussed in this account.
Kylinia alariae	*Audouinella alariae*
K. compacta	Conspecific with *Audouinella microscopica*
K. hallandica	Not recorded for New England and not discussed in this account
K. moniliformis	Conspecific with *Audouinella microscopica*
K. secundata	*Colaconema secundata*
K. unifila	*Audouinella unifila*
K. virgatula	Conspecific with *Colaconema secundata*
Rhodochorton entozoicum	See "Species Inquirendae"
R. penicilliforme	See "Collections Inquirendae" under *Audouinella spetsbergense*
R. purpurea	*Audouinella purpurea*

Name	No. erect Axes	Height	Cell diameter	Cell length	L/D	Spore Length	Spore Diameter
Audouinella alariae: Type, data from Jonsson 1901	1-2	500-1000 μm	11-23 μm below 7-11 μm above	24-56 μm below 20-72 μm above	2-3 below 3-6 above	17-22 μm	10-11 μm
Audouinella alariae: Type, data from present study	1-3	—	11-18 μm below 6-12 μm above	25-60 μm below 15-60 μm above	2-4 below 2-6 above	15-20 μm	10-12 μm
Chantransia rhipidandra: Type, data from Rosenvinge	2-3	350 μm	(7.5-) 9-11	—	2-3 (-4)	14-18 μm	9-10 μm
Chantransia rhipidandra: Type, data from this study	(1-) 2-3	450 μm	7-13	20-40 μm	2-4	15-18 μm	9-11 μm
Audouinella alariae: New England populations	1-2 (-3)	up to 1000 μm	12-18 μm below (4-) 7-10 (-15) μm above	15-60 μm below 15-65 μm above	(1-) 1.5-4 below 2-6 (-9) above	12-20 μm	8-12 μm

Table 2. Data on Populations of *Audouinella alariae* and *Chantransia rhipidandra*.

	A. dasyae	*A. intermedium*	*A. zosterae*
Height	3 mm	2 mm	3 mm
Cell diameter	6-12 (-16) μm	8-10 μm [8-11 μm]	6.4-9.6 μm [6-11 μm]
Cell length	15-70 (-90) μm	(26-) 32-64 μm [15-70 μm]	32-70 μm [21-75 μm]
L/D	2-7 (-10)	—— [2-7.5]	—— [2-7]
Monospore length	16-24 μm	19-23 μm [16-20 μm]	22-31 μm [18-24 μm]
Monosopore diameter	9-12 (-16) μm	9-13 μm [9-12 (-15) μm]	6.5-9.5 μm [8-11 μm]

Table 3. Data on populations of *A. dasyae* complex. Note: Data on *A. dasyae* is a composite of all New England collections examined. Data for *A. intermedium* and *A. zosterae* in brackets is based on personal studies of the types; data not in brackets is that reported by Jao (1936).

	A. thuretii (type)	*A. saviana* (type)	*A. saviana* (New England)
Height	up to 3 mm	up to 3 mm	up to 4 mm
Cell diameter	7-10(-13) μm	7-12 μm	(7-)8-12(-14) μm
Cell length	20-45 μm	20-40 μm	20-60 μm
L/D	2-5	1.5-4	2-6(-8)
Monospore length	15-20 μm	13-21 μm	18-27 μm
Monospore diameter	9-12 μm	8-12 μm	10-15 μm

Table 4. Data on populations of the *Audouinella saviana* complex. The first two columns represent data on type collection plants; the third is a composite of data on New England populations.

Collection	Cell Length	Cell Width	L/D	Spore Length	Spore Width
Colaconema minima (Collins data)	—	2-4 µm	1-4 (-8)	7 µm	5 µm
C. minima (Woelkerling data)	4.5-15 µm	3-7 µm	1-4	6-11 µm	3-6 µm
Chantransia emergens (Rosenvinge data)	6-10.5 µm	2-3.5 µm	—	5-6.5 µm	3-4 µm
C. emergens (Woelkerling data)	7-12 µm	3-6 µm	1-4	6-10 µm	3-5 µm

Table 5. Data on Type Collections of *Colaconema minima* and *Chantransia emergens.*

Name	Cell length	Cell width	L/D	Spore length	Spore width
Colaconema americana type collection (Jao 1936)	(16-) 22-38 (-55) µm	5-10 (-32) µm	?	6-13 µm	9.5-13 µm
Colaconema minima WJW 2693	8-25 µm	3-8 (-14) µm	2-5	7-10 µm	4-10 µm
Colaconema minima WJW 2699	10-25 (-44) µm	3-8 (-14) µm	2-6	5-8 µm	6-10 µm

Table 6. Data on New England populations of *Colaconema* found in *Asparagopsis.* (Cell dimensions refer to prostrate system filaments.)

LITERATURE CITED

ABBOTT, I. A. 1966. Observations on *Liagorophila endophytica*, a rare species in the Acrochaetiaceae (Rhodophyceae). *J. phycol.* **2**: 147-150.

ADAMS, J. 1904. *Chantransia alariae* Jonss. in the British Isles. *J. Bot.* Lond. **42**: 351-2.

AGARDH, C. A. 1817. Synopsis Algarum Scandinaviae. Lund.

__________. 1824. Systema Algarum. Lund.

__________. 1828. Species Algarum. **2** (3). Lund.

AGARDH, J. G. 1851. Species, Genera et Ordines Algarum. **2** (1). Lund.

__________. 1876. Species, Genera et Ordines Algarum. **3** (1). Epicrisis systematis Floridearum. Lund.

ARDISSONE, F. 1883. Phycologia Mediterranea. I. Floridee. Varese.

ARESCHOUG, J. S. 1847. Phycearum in maribus Scandinaviae crescunt, enumeratio. *Nova Acta R. Soc. Scient. upsal.* **13**: 223-382.

AZIZ, K. M. S. 1967. The life cycle of *Acrochaetium dasyae* Collins. *Br. phycol. Bull.* **3**: 408.

BAARDSETH, E. 1941. The marine algae of Tristan da Cunha. In "Results of Norwegian Scientific Expedition to Tristan da Cunha," **9**: 1-173. (Norske VidenskAkad: Oslo).

BAILEY, J. W. 1847-1848. Notes on the algae of the United States. *Am. J. Sci. and Arts*, II, **3**: 80-85; 399-403; 1847. **6**: 37-42; 1848.

BATTERS, E. A. 1896. Some new British marine algae. *J. Bot.*, Lond. **34**: 6-11; 384-390.

BELL, H. P., and MACFARLANE, C. 1933. The marine algae of the Maritime Provinces of Canada. I. List of Species with their distribution and prevalence. *Can. J. Res.* **9**: 265-279.

BOERGESEN, F. 1902. The marine algae of the Faeroes. In "Botany of the Faeroes," **2**: 337-532. Copenhagen.

__________. 1909. Some new or little-known West Indian Florideae. *Bot. Tidsskr.* **30**: 1-19.

__________. 1915. The marine algae of the Danish West Indies. Vol. II. Rhodophyceae. *Dansk. bot. Ark.* **3**: 1-80.

__________. 1927. Marine algae from the Canary Islands. III. Rhodophyceae. Part I. Bangiales and Nemalionales. *Biol. Meddr.* **6**(6): 1-97.

__________. 1932. Some Indian Rhodophyceae especially from the presidency of Bombay. II. *Kew Bull.* **1932**: 113-134, Plates 2-5.

__________, and JONSSON, H. 1905. The distribution of the marine algae of the Arctic sea and of the northernmost part of the Atlantic. In "Botany of the Faeroes," Appendix I-XXVIII. Copenhagen.

BONEY, A. D., and WHITE, E. B. 1967. Observations on *Kylinia rosulata* from SW. England. *J. mar. biol. Ass. U.K.* **47**: 591-596.

BORNET, E. 1904. Deux *Chantransia corymbifera* Thuret. *Acrochaetium* et *Chantransia*. *Bull. Soc. bot. Fr.* **51:** Suppl., xiv-xxiii.

BORY DE SAINT VINCENT, J. B. M. 1823. *Audouinella*. *Dict. Class. Hist. Nat.* **3:** 340-41.

COLLINS, F. S. 1880. Marine algae. pp. 157-168. *In* Robinson, J. Flora of Essex County, Massachusetts. Boston.

————————. 1883. Notes on New England marine algae. *Bull. Torrey Bot. Club* **10** (5): 55-56.

————————. 1888. Marine Algae of Nantucket. *In* Maria L. Owen, A Catalog of Plants Growing without Cultivation in the County of Nantucket, Massachusetts. 87 pp. Northampton, Mass. (Also issued as a reprint with 15 pp.; reprint pagination used in this study.)

————————. 1888a. Algae from Atlantic City, N.J., collected by S. R. Morse. *Bull. Torrey Bot. Club* **15:** 309-314.

————————. 1894. Algae. pp. 227-249. *In* E. L. Rand and J. J. Redfield, "A Preliminary Flora of Mount Desert Island, Maine." 286 pp. Cambridge, Mass.

————————. 1896. Notes on New England marine algae. VI. *Bull. Torrey Bot. Club* **23:** 1-6.

————————. 1900. Preliminary lists of New England plants. V. Marine algae. *Rhodora* **2:** 41-52.

————————. 1900a. Notes on algae. II. *Rhodora* **2:** 11-14.

————————. 1905. Phycological notes on the late Isaac Holden. I. *Rhodora* **7:** 168-172; 222-243.

————————. 1906. *Acrochaetium* and *Chantransia* in North America. *Rhodora* **8:** 189-196.

————————. 1906a. Notes on algae, VIII. *Rhodora* **8:** 157-161.

————————. 1908. Two new species of *Acrochaetium*. *Rhodora* **10:** 133-135.

————————. 1911. The marine algae of Casco Bay. *Proc. Portland Soc. Nat. Hist.* **2** (9): 257-282.

————————. 1911a. Notes on algae. X. *Rhodora* **13:** 184-187.

————————. 1913. The marine algae of Vancouver Island. *Victoria Mem. Mus. Bull.* **1:** 99-137.

————————. 1914. Drifting algae. *Rhodora* **16:** 1-5.

————————., and A. B. HERVEY. 1917. The algae of Bermuda. *Proc. Am. Acad. Arts Sci.* **53:** 1-195.

————————., I. HOLDEN, and W. A. SETCHELL. 1895. Phycotheca Boreali Americana. Vol. I. Nos. 1-50.

————————————————————. 1895a. Phycotheca Boreali Americana. Vol. II. Nos. 51-100.

————————————————————. 1896. Phycotheca Boreali Americana. Vol. IV. Nos. 151-200.

————————————————————. 1896a. Phycotheca Boreali Americana. Vol. V. Nos. 201-250.

———. 1900. Phycotheca Boreali Americana. Vol. XV. Nos. 701-750.

———. 1901. Phycotheca Boreali Americana. Vol. XVIII. Nos. 851-900.

———. 1903. Phycotheca Boreali Americana. Vol. XXII. Nos. 1051-1100.

———. 1906. Phycotheca Boreali Americana. Vol. XXVII. Nos. 1301-1350.

———. 1908. Phycotheca Boreali Americana. Vol. XXX. Nos. 1451-1500.

———. 1910. Phycotheca Boreali Americana. Vol. XXXIV. Nos. 1651-1700.

———. 1917. Phycotheca Boreali Americana. Vol. XLIV. Nos. 2151-2200.

CONWAY, E. and F. W. KNAGGS. 1966. Contributions to our knowledge of the genus *Rhodochorton:* I. *R. purpureum.* pp. 195-203. *In* Barnes, H. ed. "Some Contemporary Studies in Marine Science." London.

COTTON, A. D. 1912. Clare Island survey. Part 15. Marine algae. *Proc. R. Ir. Acad.* **31:** 1-173, Plates 1-10.

CROASDALE, H. 1941. Additional records of marine algae from New Hampshire. *Rhodora* **43:** 213-216.

DAVIS, B. M. 1913. A catalogue of the marine flora of Woods Hole and vicinity. *Dept. Comm. & Labor, Bull. U.S. Bur. Fisheries* **31**(2): 795-833.

———. 1913a. General characteristics of the algal vegetation of Buzzards Bay and Vineyard Sound in the Vicinity of Woods Hole. *Dept. Comm. & Labor, Bull. U.S. Bur. Fisheries* **31**(1): 443-544.

DE TONI, J. B. 1897-1905. "Sylloge Algarum omnium hucusque Cognitarium." 4 — Florideae. (Padua) [Issued as follows: 1897: 1-388; 1900: 387-776; 1903: 775-1525; 1905: 1523-1973].

———. 1924. "Sylloge Algarum omnium hucusque Cognitarium." 6 — Florideae. (Padua).

DILLWYN, L. W. 1802-1809. British Confervae. London. For details of dates of issue, see *Bot. Notiser* **113:** 317 (1960).

D'LACOSTE, L. E. and E. K. GANESAN. 1972. A new freshwater species of *Rhodochorton* (Rhodophyta, Nemaliales) from Venezuela. *Phycologia* **11:** 233-238.

DOTY, M. S. 1948. The flora of Penikese, seventy-four years after. I. Penikese Island marine algae. *Rhodora* **50:** 253-269.

DREW, K. M. 1928. A revision of the genera *Chantransia, Rhodochorton,* and *Acrochaetium* etc. *Univ. Calif. Publs. Bot.* **14:** 139-224, pl. 37-48.

EATON, D. C. 1873. List of marine algae collected near Eastport,

Maine, with the work of the U.S. Fish Commission under Professor S. F. Band. *Trans. Conn. Acad. Arts and Sci.* **2**: 343-350.

EDELSTEIN, T. and MCLACHLAN, J. 1966. Species of *Acrochaetium* and *Kylinia* new to North America. *Br. Phycol. Bull.* **3**(1): 37-41.

————————. 1966a. Investigations of the marine algae of Nova Scotia. I. Winter flora of the Atlantic Coast. *Can. J. Bot.* **44**: 1035-1055.

————————. 1968. Investigations of the marine algae of Nova Scotia. V. Additional species new or rare to Nova Scotia. *Can. J. Bot.* **46**: 993-1003.

————————. 1969. Investigations of the marine algae of Nova Scotia. VI. Some species new to North America. *Can. J. Bot.* **47**: 555-560.

————, L. CHEN, and J. MCLACHLAN. 1970. Investigations of the marine algae of Nova Scotia. VIII. The flora of Digby Neck Peninsula, Bay of Fundy. *Can. J. Bot.* **48**: 621-629.

————, MCLACHLAN, J., and CRAIGIE, J. S. 1967. Investigations of the marine algae of Nova Scotia. II. Species of Rhodophyceae new or rare to Nova Scotia. *Can. J. Bot.* **45**: 193-202. pl. 1-8.

ERSKINE, D. 1955. Two red algae new to Nova Scotia. *Can. Field Nat.* **69**: 150-151.

FARLOW, W. G. 1875. List of the marine algae of the United States with notes of new or imperfectly known species. *Proc. Am. Acad. Arts and Sci.* **10**(11): 351-380.

————. 1876. List of the marine algae of the United States. *Rep. U.S. Fish Comm. for 1875*: 691-718. (Also issued as a reprint bearing the page numbers 1-28.)

————. 1877. On some algae new to the United States. *Proc. Am. Acad. Arts and Sci.* **12**: 235-245.

————. 1879. List of Algae collected at points in Cumberland Sound during the autumn of 1877. *Bull. U.S. Nat. Mus.* **15**: 169.

————. 1881. The marine algae of New England. *Rep. U.S. Commr. Fish. for 1879*, Appendix A-1, 1-210 (1882). (See Taylor 1957, p. 354 concerning the publication date of this paper.)

————, ANDERSON, G. and EATON, D. C. 1881. Algae Americana Borealis Exsiccatae. Vol. 4.

FELDMANN, J. 1942. Les algues marines de la cote des Alberes. IV. Rhodophycees. 196 pp. Paris.

GIARD, A. 1890. Le laboratoire de Wimereux en 1889. *Bull. Sci. Fr. Belg.* **22**: 258-284. Note: This article has also been issued as a reprint bearing the page numbers 60-87.

GIBSON, R. J. H. 1891. On the development of the sporangia in *Rhodochorton rothii* Naeg. and *R. floridulum* Naeg; and on a new

species of that genus. *Proc. Linn. Soc. (Bot.)* **28**: 201-205, Plate 38.

GRIER, N. M. 1925. The native flora of the vicinity of Cold Spring Harbor, Long Island, New York. *Am. Midland Nat.* **9**: 245-256; 283-318; 384-437; 514-527; 550-563.

HALL, F. W. 1876. List of algae growing in Long Island Sound within 20 miles of New Haven. *Bull. Torrey Bot. Club* **6**: 109-112.

HAMEL, G. 1927. Recherches sur les genres *Acrochaetium* Naeg. et *Rhodochorton* Naeg. Dissertation. Paris.

————. 1928. Sur les genres *Acrochaetium* Naeg. et *Rhodochorton* Naeg. *Revue algol.* **3**: 159-210.

————. 1928a. Floridees de France. V. *Revue algol.* **3**: 99-158.

HARVEY, W. H. 1833. Cryptogamia algae. Div. II. Confervoideae. In W. J. Hooker, "The English Flora of Sir James Edward Smith." Class XXIV. *Cryptogamia.* **5**. London.

————. 1841. A Manual of the British Marine Algae. London.

————. 1846. Phycologia Britannica. **1**. London.

————. 1849. A Manual of British Marine Algae. 2nd. Ed. London.

————. 1853. Nereis Boreali-Americana. Part II. Rhosospermae. *Smithson. Contr. Knowl.* **5**(5): 1-258, Plates 13-36.

————, and MACKAY, J. T. 1836. Algae. In J. T. Mackay, "Flora Hibernica." **2**(3). London.

HARVEY-GIBSON, R. J. See Gibson, R. J. H.

HAUCK, F. 1885. Die meeresalgen Deutschlands und Oesterreichs. In L. Rabenhorst, "Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz." **2**. Leigzig.

————, and P. RICHTER. 1888. Phykotheka Universalis. **4**. Nos. 151-200.

————. 1892. Phykotheka Universalis. **10**. Nos. 451-500.

HAY, G. U. 1887. Marine algae of the Maritime Provinces. *Bull. New Brunswick Nat. Hist. Soc.* **1**(6): 62-68.

————, and MACKAY, A. H. 1888. Marine algae of New Brunswick: with an appendix containing a list of the marine algae of the Maritime Provinces of the Dominion of Canada. *Trans. Roy. Soc. Canada* **5**: 167-174.

HEHRE, E. J. and A. C. MATHIESON. 1970. Investigations of New England marine algae. III. Composition, seasonal occurrence and reproductive periodicity of the marine rhodophyceae in New Hampshire. *Rhodora* **72**: 194-239.

HOWE, M. A. 1914. The marine algae of Peru. *Mem. Torrey Bot. Club* **15**: 1-185, Plates 1-66.

————. 1918. Algae, pp. 489-540. In Britton, N. L. Flora of Bermuda. 1x + 585. New York.

HUDSON, G. 1778. Flora Anglica. 2 ed. xxxii + 688 pp. London. Note: A reprint of this edition bears the date 1798.

HYLANDER, C. J. 1928. The Algae of Connecticut. [Conn.] *State Geol. and Nat. Hist. Sur. Bull.* **42:** 1-245.

JAO, C. C. 1936. New Rhodophyceae from Woods Hole. *Bull. Torrey bot. Club* **63:** 237-257.

JELLIFFE, S. E. 1899. The Flora of Long Island. Lancaster, Pa.

——————. 1904. Additions to the flora of Long Island. *Torreya* **4:** 97-100.

JONSSON, H. 1901. The marine algae of Iceland. 1. Rhodophyceae. *Bot. Tidsskr.* **24**(2): 127-155.

JORDAN, D. S. 1874. The flora of Penikese Island. *Am. Nat.* **8:** 193-197.

——————. 1874a. A key to the higher algae of the Atlantic Coast. II. Rhodospermae. *Am. Nat.* **8:** 479-488. (Also issued as a reprint (combined with parts I & III) bearing the page numbers 9-17.)

JORDE, I. and N. KLAVESTAD. 1963. The natural history of the Hardengerfjord. 4. The benthonic algal vegetation. *Sarsia* **9:** 1-99.

KJELLMAN, F. R. 1875. Om Spetsbergens marine, Klorofyllfoerande thallophyter 1. *Bih. K. Svenska Vetensk Akad. Handl.* **3**(7): 1-34.

——————. 1877. Ueber die algenvegetation des Murmanschen Meeres an der Westkueste von Nowaja Semlja und Wajgatsch. *K. Ges. Wissensch., Upsala* **3.** pp. 1-86.

——————. 1877a. Bidrag till kaennedomen af kariskahafuets Alguegetation. *K. Svenska Vetensk. Akad. Oefuersigt.* **34**(2): 3-30, taf. 1.

——————. 1883. The algae of the arctic sea. *K. Svenska Vetensk Akad. Handl.* **20**(5): 1-350.

——————. 1906. Zur Kenntnis der marinen Algenflora von Jan Mayen. *Ark. Bot.* **5**(14): 1-30. taf. 1-3.

KLUGH, A. B. 1917. The marine algae of the Passamaquoddy region, New Brunswick. *Contrib. Can. Biol.* **1915–1916:** 79-85.

KNAGGS, F. W. 1965. *Rhodochorton purpureum* (Lightfoot) Rosenvinge: Observations on the relationship between morphology and environment. I. *Nova Hedwigia* **10:** 499-513. pl. 150(1)-156(7).

——————. 1966. *Rhodochorton purpureum* (Lightf.) Rosenvinge: Observations on the relationship between morphology and environment. II. *Nova Hedwigia* **11:** 337-349, Plates 43-45.

——————. 1966a. *Rhodochorton purpureum* (Lightf.) Rosenvinge: Observations on the relationship between reproduction and environment. I. The relationship between the energy of incident light and tetrasporangium production. *Nova Hedwigia* **11:** 405-411.

———————. 1966b. *Rhodochorton purpureum* (Lightf.) Rosenvinge: Observations on the relationship between morphology and environment. III. *Nova Hedwigia* **12:** 521-528.

——————— 1967. Modified sporangia on the tetrasporophyte of *Rhodochorton purpureum* (Lightf.) Rosenvinge *Nova Hedwigia* **13:** 139-143.

———————. 1967a. A review of the world distribution and ecology of *Rhodochorton purpureum* (Lightf.) Rosenvinge. *Nova Hedwigia* **14:** 549-570.

———————. 1968. *Rhodochorton purpureum* (Lightf.) Rosenvinge: The morphology of the gametophytes and young carposporophytes. *Nova Hedwigia* **16:** 449-458.

KUCKUCK, P. 1897. Beitraege zur Kenntnis der Meeresalgen. 2. Ueber *Rhodochorton membranaceum* Magnus, eine chitinbewohnende Alge. *Wiss. Meeresunters.* (Abt. Helgoland) N. F. **1:** 337-348.

KUETZING, F. T. 1861. Tabulae Phycologicae. XI. Band. Nordhausen.

KYLIN, H. 1906. Zur Kenntnis einiger schwedischen *Chantransia*-arten. In "Botaniska Studier till F. R. Kjellman." pp. 113-126. Uppsala.

—————. 1907. Studien ueber die Algenflora der Schwedischen Westkueste. Dissertation. Uppsala.

—————. 1910. Zur Kenntnis der norwegischen Westkueste. *Ark. Bot.* **10**(1): 1-37.

—————. 1925. The marine red algae in the vicinity of the biological station at Friday Harbour, Wash. *Acta Univ. Lund.* (N. F. Avd. 2) **21**(9): 1-87.

—————. 1928. Entwicklungsgeschichtliche Florideenstudien. *Acta Univ. Lund* (N. F. Avd. 2) **24**(4): 1-127.

—————. 1941. Californische Rhodophyceen. *Acta Univ. Lund.* (N. F. Avd. 2) **37**(2): 1-51, taf. 1-13.

—————. 1944. Die Rhodophyceen der Schwedischen Westkueste. *Acta Univ. Lund.* (N. F. Avd. 2) **40**(2): 1-104, taf. 1-32.

LANJOUW, J., and STAFLEU, F. A. 1964. Index Herbariorum. Part I — The Herbaria of the World. 5th. Ed. *Regnum Vegetabile* **31:** 1-251.

LEJOLIS, A. 1863. Liste des Algues Marines de Cherbourg. 167 pp. Paris. Note: The contents of this book also appeared in *Mem. Soc. Imp. Sci. Nat. Cherbourg* **10:** 1-167 dated 1864 and was reprinted as a book in 1880.

LEVRING, T. 1935. Zur Kenntnis der Algenflora von Kullen an der Schwedischen Westkueste. *Acta Univ. Lund.* (N. F. Avd. 2) **31**(4): 1-63.

—————. 1935a. Ueber einige Meeresalgen bei Kristineberg an der Schwedischen Westkueste. *Bot. Notiser* **1935:** 455-463.

———. 1937. Zur Kenntnis der Algenflora der Norwegischen Westkueste. *Acta Univ. Lund.* (N. F. Avd. 2) **33**(8): 1-147, taf. 1-4.

———. 1940. Studien ueber die Algenvegetation von Blekinge, Suedschweden. Dissertation. Lund.

———. 1942. Meeresalgen aus dem Adriatischen Meer, Sizilien, und dem Golf von Neapal. *K. Fysiogr. sallsk. Lund. Forh.* **12**(3): 1-17.

———. 1945. Marine algae from some antarctic and subantarctic islands. *Acta Univ. Lund.* (N. F. Avd. 2) **41**(7): 1-36.

———. 1953. The marine algae of Australia. I. Rhodophyta: Goniotrichales, Bangiales, and Nemalionales. *Ark. Bot.* (2) **2**(6): 457-530.

LEWIS, I. F. (ed.) 1924. The flora of the Penikese, fifty-years after. *Rhodora* **26**: 181-195; 211-219; 222-229.

LIGHTFOOT, J. 1777. Flora Scotica. 2. London.

LUND, S. 1959. The marine algae of East Greenland. I. Taxonomical Part. *Meddr. Groenland* **156**(1): 1-247.

LYNGBYE, H. 1819. Tentamen Hydrophytologiae Danicae. Copenhagen.

MAGNUS, P. 1874. Die botanischen Ergebnisse der Nordseefahrt vom 21 Juli bis 9 September 1872. *Wiss. Meeresunters.* **2**: 59-79.

MARTINDALE, I. 1889. Marine algae of the New Jersey coast and adjacent waters of Staten Island. *Mem. Torrey Bot. Club* **1**: 87-109.

MARTIUS, K. 1817. Flora Cryptogamia Erlangensis. Norimbergae.

MATHIESON, A. C., C. J. DAWES, and H. J. HUMM. 1969. Contributions to the marine algae of Newfoundland. *Rhodora* **71**: 110-159.

MENEGHINI, G. 1840. Botanische Notizen. *Flora* (Regensburg) **23**(2): 510-512. Note: This appears to be the published form of a document often cited in literature as "Lettera al Dott. Iacob Corinaldi a Pisa." (1840).

MONTAGNE, J. P. 1856. Sylloge Generum Specierumque Plantarum Cryptogamarum. Paris.

NAEGELI, C. 1861. Beitraege zur morphologie und systematik der Ceramiaceae. *Sber. bayer. Akad. Wiss.* **2**: 297-415.

NAKAMURA, Y. 1941. The species of *Rhodochorton* from Japan. I. *Scient. Pap. Inst. Algol. Res. Hokkaido Univ.* **2**(2): 273-291.

———. 1944. The species of *Rhodochorton* from Japan. II. *Scient. Pap. Inst. Algol. Res. Hokkaido Univ.* **3**(1): 99-119.

OLNEY, S. T. 1871. Algae Rhodiaceae, A List of Rhode Island Algae, etc. 12 pp. Providence.

———. 1872. Algae Rhodiaceae. *The Lens* **1**: 129-135.

PAPENFUSS, G. F. 1945. Review of the *Acrochaetium — Rhodochorton* complex of the red algae. *Univ. Calif. Publs. Bot.* **18**(14): 299-334.

———————. 1947. Further contributions toward an understanding of the *Acrochaetium — Rhodochorton* complex of the red algae. *Univ. Calif. Publs. Bot.* **18**(19): 433-447.

PIKE, N. 1886. Checklist of marine algae. Based on specimens collected on the shores of Long Island from 1839 to 1885. *Bull. Torrey Bot. Club* **13**: 105-114.

PRINGSHEIM, N. 1862. Beitrage zur Morphologie der Meeresalgen. *Abh. Preuss. Akad. Wiss.* **1862**: 1-37, Plates 1-8.

REINSCH, P. F. 1879. Beobachten ueber entophyte und entozoische Pflanzenparasiten. *Bot. Ztg.* **37**: 17-24; 33-44. Taf. 1.

ROSENVINGE, L. K. 1893. Goenlands Havalger. *Meddr. Groenland.* **3**: 765-981. Pl. 1-2.

——————— 1894. Les algues marines du Groenland. *Annls. Sci. Nat.* (7) **19**: 53-164.

———————. 1900. Note sur le une Floridee aerienne (*Rhodochorton islandicum* nov. sp.). *Bot. Tidsskr.* **23**: 61-81.

——————— 1909. The marine algae of Denmark. I. Rhodophyceae 1. *K. Danske Vidensk. Selsk. Skr.* (Afd. 7, Raekke) **7**(1): 1-151.

——————— 1923-1924. The marine algae of Denmark. I. Rhodophyceae 3. *K. danske Videnske Selsk. Skr.* (Afd. 7, Raekke) **7**(3): 285-487.

———————. 1935. Distribution of the Rhodophyceae in the Danish waters. *K. danske Vidensk. Selsk. Skr.* (Afd. 9, Raekke) **6**(2): 1-44.

ROTH, A. G. 1797-1806. Catalecta Botanica quibus Plantae Novae et minus Cognitae Describuntur atque Illustrantur. Leipzig.

SCHIFFNER, V. 1916. Studien ueber Algen des Adraitischen Meeres. *Wiss. Meeresunters.* (Abt. Helgoland) (N. F.) **11**(2): 127-198.

———————. 1931. Neue und bemerkenswerte Meeresalgen. *Hedwigia* **71**: 139-205.

SCHMITZ, F. and P. FALKENBERG. 1897. Rhodomelaceae. *In* A. Engler und K. Prantl, "Die Naturlichen Pflanzen familien." **1**(2). Leipzig.

SIRODOT, S. 1876. Le *Balbiania investiens* étude organogénique et physiologique. *Ann. Sci. Nat.* (*Bot.*) (6), **3**: 146-174.

SOUTH, G. R. 1970. Checklist of marine algae from Newfoundland, Labrador, and the French Islands of St. Pierre and Miquelon. Mar. Sci. Res. Lab. (Memorial University of Newfoundland) Technical Report No. 2. iv + 20 pp.

———————, and A. CARDINAL. 1970. A checklist of marine algae of Eastern Canada. *Can. J. Bot.* **48**: 2077-2095.

STONE, R. A., E. J. HEHRE, J. M. CONWAY, and A. C. MATHIESON. 1970. A preliminary checklist of the marine algae of Campabello Island, New Brunswick, Canada. *Rhodora* **72**: 313-338.

SUNDENE, O. 1953. The algal vegetation of Oslofjord. *Norske Vidensk. Oslo. I. Mat. — Naturw. Klasse* **1953**(2): 1-244.

TAYLOR, W. R. 1928. The marine algae of Florida with special reference to the Dry Tortugas. *Pap. Tortugas Lab.* **25**: 1-219.

————. 1937. Marine Algae of the Northeastern Coast of North America. IX + 427. Ann Arbor, Michigan.

————. 1941. Notes on the marine algae of Texas. *Pap. Mich. Acad. Sci.* **26**: 69-79.

————. 1957. Marine Algae of the Northeastern Coast of North America. 2nd. Ed. Ann Arbor.

————. 1960. Marine Algae of the Eastern Tropical and Subtropical Coasts of the Americas. Ann Arbor.

TURTON, W. 1806. A General System of Nature. **3**. London.

VALERA, M. DE 1939. Some new or critical algae from Galway Bay, Ireland. *K. fysiogr. Sallsk. Lund. Forh.* **9**(9): 1-14.

VICKERS, A. 1905. Liste des algues marine de la Barbade. *Ann. Sci. Nat.* (*Bot.*) (9) **1**: 45-66.

WEBER VAN BOSSE, A. 1921. Liste des algues du Siboga. II. Rhodophyceae. Part I. Protoflorideae, Nemalionales, Cryptonemiales. Siboga-Exped. Monogr. No. 59B, 187-310, Plates 8-10.

WEST, J. A. 1967. The life histories of *Rhodochorton purpureum* and *Rhodochorton tenue* in culture. *J. phycol.* **3**(Suppl.), 11.

————. 1968. Morphology and reproduction of the red alga *Acrochaetium pectinatum* in culture. *J. phycol.* **4**: 89-99.

————. 1969. The life histories of *Rhodochorton purpureum* and *R. tenue* in culture. *J. phycol.* **5**: 12-21.

————. 1970. A monoecious isolate of *Rhodochorton purpureum*. *J. phycol.* **6**: 368-370.

————. 1970a. The Life history of *Rhodochorton concrescens* in culture. *Br. phycol. J.* **5**: 179-186.

WHELDEN, R. M. 1947. Algae. pp. 13-127. In Polunin, N. ed. Botany of the Eastern Canadian Arctic. Part II. Thallophyta and Bryophyta. *Bull. Nat. Mus. Canada.* **97**: 1-573.

WOELKERLING, W. J. 1970. *Acrochaetium botryocarpum* (Harvey) J. Ag. in Southern Australia. *Br. phycol. J.* **5**(2): 159-171.

————. 1971. Morphology and taxonomy of the *Audouinella* complex (Rhodophyta) in Southern Australia. *Aust. J. Bot., Suppl. Ser.* Suppl. 1. 91 pp.

————. 1972. Studies on the *Audouinella microscopica* (Naeg.) Woelk. complex (Rhodophyta). *Rhodora* **74**: 85-96.

————. 1973. The *Audouinella* complex (Rhodophyta) in the Western Sargarso Sea. *Rhodora:* **75**: 78-101.

YAMADA, Y. 1944. Notes on some Japanese algae. 10. *Sci. Pap. Inst. algol. Res. Hokkaido Univ.* **3**: 11-25.

DEPARTMENT OF BOTANY
UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN 53706

BOOK REVIEW

THE GENUS LESQUERELLA (CRUCIFERAE) IN NORTH AMERICA[1]

It is quite satisfying and even reassuring in these times to encounter a substantial taxonomic work unencumbered by flights of fancy. It seems commendable for the authors to state on page 33, "We see little to be gained by putting our own speculations concerning a detailed phylogeny into print." The gift of imagination is good if rightly used but it is no substitute for hard work and relentless probing after facts which are both so well exemplified in the attractive, informative and impressive volume under review.

In their introduction the authors explain that, for more than thirty years, collecting and field studies of *Lesquerella* have been carried on by the senior author. They state that this treatment includes sixty-nine species and twenty-nine infraspecific taxa but excludes some dozen species of South America. It is obviously too much to have asked of the present authors that they studied these exotic species with anything like the detail and care given to the North American areas, their study embracing the examination of 9000 sheets, the study of wild populations, the experimental culture of some taxa, the determination of chromosome numbers and the examination of type material.

Following the introduction is a discussion of the limits of the genus, understandably an important consideration in the Cruciferae. The extent of their coverage of *Lesquerella* is indicated by merely listing the remaining topics treated in the first thirty-five pages, breeding system, interspecific hybridization, chemical information of systematic value, the type species and subdivisions of the genus, chromosome numbers, pollen, trichomes, taxonomic characters and evolution within the genus.

[1]Rollins, Reed C. and Elizabeth A. Shaw. The Genus *Lesquerella* (Cruciferae) in North America. pub. date 6 June 1973. Harvard University Press, Cambridge, Massachusetts. X pp 1-288, illustra., $18.00.

It is of interest to note that an aneuploid relationship was found to occur frequently between species of *Lesquerella*. Also in some cases infraspecific polyploidy was found to occur accompanied by evolutionary changes and sometimes not. The following statement by Rollins and Shaw on p. 12 would seem to suggest a reasonable taxonomic handling of this kind of problem, "If no significant and readily detectable morphological physiological or ecological changes have followed the event of chromosome complement multiplication within a species then there is little justification for insisting that the taxonomy merely reflect the ployploid picture."

Scanning electron microscope photographs strikingly illusrate the types of pollen and details of the variety of trichomes in *Lesquerella*. Indeed the book throughout is well illustrated with readily accessible plates, figures and maps. Particularly in the main body of the treatment, beginning on p. 36, and dealing with the taxonomy of the group, it is refreshing to note the uncrowded handling of taxa and the convenient juxtaposition of illustrations, descriptive material and discussions.

It is of particular importance to call attention to the fact that many new combinations and a number of new species are published by Rollins and Shaw in this work.

The use by Rollins and Shaw of two important infraspecific categories, those of subspecies and variety seems to work out realistically though the authors don't seem to explain in all cases what their reasons are for preferring one or the other rank.

There are unresolved questions raised by the authors but they seem in this treatment to have done all they might have done with *Lesquerella* at this time.

ALBION R. HODGDON
DEPARTMENT OF BOTANY & PLANT PATHOLOGY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824

INSTRUCTIONS FOR CONTRIBUTORS TO RHODORA

Manuscripts must be double-spaced or preferably triple-spaced (not on corrasable bond), and a list of legends for figures and maps provided on a separate page. Footnotes should be used sparingly, as they are usually not necessary. Do not indicate the style of type through the use of capitals or underscoring, particularly in the citations of specimens, except that the names of species and genera may be underlined to indicate italics in discussions. Specimen citations should be selected critically especially for common species of broad distribution. Systematic revisions and similar papers should be prepared in the format of "The Systematics and Ecology of Poison-Ivy and the Poison-Oaks," W. T. Gillis, Rhodora 73: 161-237, 370-443. 1971, particularly with reference to the indentation of keys and synonyms. Papers of a floristic nature should follow, as far as possible, the format of "Contribution to the Fungus Flora of Northeastern North America. V.," H. E. Bigelow & M. E. Barr, Rhodora 71: 177-203. 1969. For bibliographic citations, a recommended list of standard journal abbreviations is given by L. Schwarten & H. W. Rickett, Bull. Torrey Bot. Club 85: 277-300. 1958.

Volume 75, No. 804, including pages 493-644, was issued December 31, 1973

Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

ALBION REED HODGDON, Editor-in-Chief

ROLLA MILTON TRYON
RADCLIFFE BARNES PIKE
STEPHEN ALAN SPONGBERG
GERALD JOSEPH GASTONY
ALFRED LINN BOGLE
RICHARD EDWIN WEAVER

Associate Editors

VOLUME 75

1973

The New England Botanical Club, Inc.

Botanical Museum, Oxford St., Cambridge, Mass. 02138

INDEX TO VOLUME 75

New scientific names and combinations are printed in bold face type

Abies balsamea 314
Acacia tortuosa 416
Acalypha setosa 393
Acerates hirtella 398
Achillea millefolium 321
Acnida cannabina 57
Acorus calamus 54, 57, 61, 316
Acrochaetium alariae 541, 543-545; alcyonidii 273, 551, 554-556, 607; var. cylindricum 551, 554; americanum 588; amphiroae 551, 556, 607; antillarum 92; attenuatum 583, 607; avrainvillae 89, 563; bornetii 88, 557, 592; catenulatum 86, 557; collopodum 86, 557; compactum 86, 557; crassipes 86, 557; dasyae 273, 545, 602; daviesii 81, 550, 577, 602; dufourii 84, 85, 97; efflorescens 584; effusum 92; emergens 572, 607; endophyticum 92, 574; endozoicum 592; flexuosum 273, 532, 577, 582, 602; hallandicum 82; humile 569; hypneae 563; inclusum 592; infestans 89; intermedium 545, 548, 549, 607; kylinii 574, 592; Levringii 87; luxurians 94, 97, 575; microfilum 87, 558, 583, 607; microscopicum 86, 557; minimum 572, 607; moniliforme 87, 558; Nemalionis 89; opetigenum 549; pallens 563; polyides 587, 588, 607; radiatum 273, 569, 571, 583, 604, 607; ralfsiae 592; rhipidandra 541; robustum 549; sagraeanum 532, 551, 556, 590, 591, 593, 607; sagraeanum 560, 562, 577, 582; sargassi 84, 85, 97; savianum 560; secundatum 94, 575; subseriatum 545, 548; subsimplex 575, 582; subtilissimum 592; tenuissimum 576; thuretii 88, 551, 556, 560, 562, 563, 607; trifilum 272, 273; unifilum 563; unipes 549; virgatula 96, 97; virgatulum 94, 273, 576; f. luxurians 273, 576; f. tenuissimum 576; zosterae 545, 548, 549, 607
Actinastrum 266
Agardhiella tenera 274
Ageratum conyzoides 422; ssp. conyzoides 422; ssp. latifolium 422; latifolium 422
Agmenellum thermale 282; quadruplicatum 282
Agropyron repens, f. aristatum 314; f. pilosum 314; f. trichorrachis 314
Agrostis perennans 315; scabra 315; stolonifera, var. major 315; var. palustris 315; tenuis, f. aristata 315
Alabama and Middle Tennessee, Some Notes on the Flora of the Southern States, Particularly 366
Alaria esculenta 543
Alaska, New Record for the Yellow Lady's Slipper Orchid, Cypripedium calceolus L. ssp. parviflorum (Salisb.) Hult. from 491
Alaskan Species of Erigeron L. (Compositae), A New 116

Algae, Benthic, and Vascular Plants of the Lower Merrimack River and Adjacent Shoreline 52; of Virginia and Maryland, Including the Chesapeake Bay Area, the Marine 258
Allium cernuum 385; stellatum 384
Alnus crispa, var. mollis 317; rugosa, var. americana 317
Alopecurus pratensis 315
Alysicarpus vaginalis 390
Ambrosia artimisiifolia, var. elatior 321; bidentata 407
Amellus asper, var. canescens 192; var. glabriusculus 194; var. normalis 192
Ammophila breviligulata 56, 315
Amphicarpon floridanum 374; muhlenbergianum 374
Amphipleura rutilans 59, 60
Amsonia rigida 398
Anabaena inaequalis 292; sphaerica 292; torulosa 292
Anacystis cyanea 282; dimidiata 282; marina 283; montana, f. minor 283; f. montana 283; thermalis, f. thermalis 283
Anaphalis margaritacea, var. intercedens 321; var. subalpina 321
Andropogon arctatus 374; capillipes 375; divergens 375; hirtiflorus 375; littoralis 375; niveus 375; perangustatus 376; ternarius 374
Anthoxanthum odoratum 315
Antigonon leptopus 386
Antithamnion cruciatum 276
Aquatic and Wetland Plants of the Southwestern United States (Review) 114
Aralia hispida 319
Arenaria lateriflora 317; peploides, var. robusta 317
Arethusa bulbosa 316
Aristida tuberculosa 371
Aronia melanocarpa 390
Artemisia ludoviciana 409; stelleriana 56, 511
Arthrocladia villosa 564
Arthrospira brevis 284
Asclepias aceratoides 399; hirtella 398; quadrifolia 160; tomentosa 399; verticillata 135
Ascocyclus orbicularis 269
Ascophyllum nodosum 58, 271; f. scorpioides 271
Asparagopsis hamifera 273, 274
Asperococcus echinatus 270
Asplenium trichomanes 167
Aster acuminatus 1-4, 6-9, 11, 12, 15, 17-19, 21, 22, 27, 30, 321; Blakei 1-4, 6-9, 11-16, 17, 19-22; Chemical, Cytological and Genetic Evidence for the Hybridization of 1; X Blakei 321; chapmanii 405; Chromosome Numbers in 26; ciliolatus 27, 30; concinnus 26, 27, 30; cordifolius 27, 30; dumosus 166; eryngiifolius 405; foliaceus, var. arcuans 321; gracilis 26, 27, 30; johannensis 321; junciformis 27, 30; lateriflorus 27, 30; lowerianus 28, 30; macrophyllus 28, 30; nemoralis 1-4, 6-9, 11, 12, 15, 17-22, 321; x acuminatus 13-15; novi belgii 56; patens 28, 31; pilosus 28, 31; puniceus 28, 31; sagittifolius 28, 31; simplex 28, 31; spectabilis 29, 31, 405; subulatus 57; umbellatus 29, 31, 321; undulatus 26, 29, 31
Astragalus atlasovi 304, 305; polaris 304; A Range Extension and a New Synonym for 304; tennesseensis 135, 136, 138
Athanasia hastata 184, 185
Athyrium filix-femina, var. michauxii, f. rubellum 314

Atriplex glabriuscula 314; patula 53; var. hastata 56, 106-110, 317; Variation in the Seed Size of 106
Audouinella **alariae** 534, 541, 543-545, 550, 555, 596 fig., 597 fig., 608, 609; attenuatum 584; australis 564, 565; Complex (Acrochaetiaceae, Rhodophyta) in the Northeastern United States, The Morphology and Systematics of the 529; Complex (Rhodophyta) in the Western Sargasso Sea, The 78; **dasyae** 534, 545, 547-550, 598, 599, 607, 610; daviesii 79, 81, 82, 533, 550, 553-556, 563, 582, 585, 591, 592; efflorescens 557, 584, 585, 608; **hallandica** 79, 80, 82, 83, 85, 97; hermanni 535; intermedium 610; membranacea 566, 608; microscopica 79, 80, 86, 88, 534, 557, 559, 565, 583, 601, 607, 608; **purpurea** 530, 534, 536, 539-41, 568, 587, 601, 608; saviana 534, 560-63, 584, 591, 592, 602, 607, 610; **spetsbergense** 585, 587, 603, 608; thuretii 79, 81, 88, 89, 560, 610; **unifila** 534, 563, 565, 601; zosterae 610
Averett, John E., Biosystematic Study of Chamaesaracha (Solanaceae) 325
Avicennia germinans 102-105; Salt Concentrations in Ground Waters Beneath Rhizophora mangle and 102
Azalea austrina 396
Azorella selago 241

Bahama Flora Since Britton and Mllspaugh, Additions to the 411
Bangia ciliaris 272; fuscopurpurea 272
Baptisia australis 159
Barkley, T. M. see Kowal, Robert R.
Barneby, R. C., A Range Extension and a New Synonym for Astragalus polaris, Benth. 304
Baskin, Carol C. see Baskin Jerry M.
Baskin, Jerry M. and Carol C. Baskin, The Past and Present Geographical Distribution of Petalostemon foliosus and Notes on Its Ecology 132
Betula papyrifera, var. cordifolia 316
Bidens cernua 321, 408; frondosa 321; nivea 170, 171, 184; tripartita 408
Blidingia minima 58
Bocconia frutescens 415
Boehmeria nivea 386
Book reviews 114, 140, 323, 622
Bostrychia radicans 280; f. moniliforme 280; rivularis 280
Botrychium biternatum 366; lunarioides 366
Boufford, David E., New or Noteworthy New Hampshire Plants 158
Bougainvillea glabra 415
Bowler, Peter A. and Phillip W. Rundel, The Status of Ramalina subampliata (Nyl.) Fink in North America 306
Bowley, Donovan R., The Environment of Schistostega pennati (Hedw.) Hook & Tayl.: New Vermont Stations 149
Brachiaria extensa 372; platyphylla 372
Bryopsis hypnoides 267; plumosa 327
Bulbostylis capillaris 378
Byssus purpurea 536

Cacalia diversifolia 409; tuberosa 136

Caesalpina divergens 416
Cakile edentula 318
Calamagrostis canadensis, var. canadensis 315
Calea aspera 171, 192
Callicarpa americana 420
Callithamnion baileyi 276; byssoides 276; corymbosum 276; daviesii 81, 550, 555, 577; var. secundatum 94, 575; efflorescens 584; entozoicum 569, 589; luxurians 94, 96, 575; membranaceum 566, microscopicum 86, 557; purpureum 536; rothii 537; savianus 560, 563, secundata 94, 575; virgatulum 94, 545, 550, 576, 581
Callitriche verna 319
Caloglossa lepricurii 279
Calopogon tuberosus 316
Calothrix confervicola 292; crustaceae 292; pulvinata 293
Canna flaccida 385
Capsella bursa-pastoris 318
Cardamine bulbosa 388; douglassii 388; pratensis 160
Carex abscondita 251; aestivalis 251, 253; alata 251, 253; albolutescens 250, 254; albursina 250, 253; amphibola 250; annectens 250; arenaria 252; argyrantha 250, 253; artitecta 250; atlantica 250; austro-caroliniana 380; baileyi 251, 254; barrattii 251, 253; Bigelowii 156; biltmoreana 249, 252, 253; blanda 250; brevior 249, 253; bromoides 250, 254; brunnescens 249, 253; var. sphaerostachya 315; bullata 251, 253; bushii 250, 253; buxbaumii 249, 254, 255; canescens 249, 254; var. disjuncta 315; var. subloliacea 315; capitata 155, 156; careyana 250, 253; caroliniana 250; cephalantha 315; cephalophora 250; chapmannii 249, 252, 253; cherokeensis 249, 251, 253; collinsii 251, 253; communis 250, 253, 380; comosa 250, 253; complanata 250; conjuncta 250, 253; conoidea 316; crawei 381; crebriflora 251; crinita 250; cristatella 250, 253; crus-corvi 251, 253; dasycarpa 381; debilis 250; decomposita 251, 253; dichotoma 269; digitalis 250; divisa 252; eburnea 250, 253; emmonsii 250, 253; extensa 249, 252; festucacea 250; flaccosperma 251; folliculata 250, 254; frankii 250; gigantea 251, 253; glaucescens 251, 253; gracilescens 250; gracillima 251; granularis 250; grayi 251, 253; grisea 250; hitchcockiana 251, 253; hormothodes 315; howei 250, 253; hyalinolepis 251, 253; hystricina 250, 253; interior 250, 253; intumescens 250, 252; jamesii 250, 254; joori 251, 253; kobomugi 252; laevivaginata 250; lasiocarpa 249, 254, 255; laxiculmis 251; laxiflora 250; leavenworthii 250; leptonervia 251, 253; leptalea 250, 254, 316; louisianica 251, 253; lupuliformis 250, 253; lupulina 250; lurida 249, 250; microdonta 381; muhlenbergii 250; muricata 249, 253; nigromarginata 250; normalis 251; novi-angliae 316; oligocarpa 250, 254; oxylepis 251, 253; paleacea 316; pallescens 249, 253; var. neogaea 316; paupercula, var. irrigua 316; pedunculata 249; pensylvanica 249; physorhyncha 250; plantaginea 167, 251, 253; platyphylla 251; polymorpha 249, 251, 253; prasina 251,

254; reniformis 251, 253; retroflexa 250; rosea 250; rostrata 249, 253; salina 56; scabrata 251, 254; scoparia 250; scorsa 251, 254; shortiana 251, 253; sparganoides 250, 254; spicata 252; squarrosa 251; stipata 250, 315; striatula 250; stricta 250; styloflexa 250; suberecta 251, 253; swanii 251, 254; tenera 251; tenax 381; tetanica 249, 251, 253; torta 251, 254; tribuloides 250, 315; trichocarpa 249, 251, 253; trisperma 251, 253, 315; typhina 250, 253; umbellata 250, 253; validior 381; venusta 251, 253; vestita 251, 253; virescens 251, 254; viridula 316; vulpinoidea 250; walteriana 251, 253; willdenowii 250, 254; woodii 249, 251, 253

Carices of Virginia, Phytogeography of the 248

Carum carvi 319

Carya alba 38; cordiformis 34, 36, 38, 41, 48; glabra 34, 36, 37, 44; var. odorata 34; glabra-ovalis 44, 46, 47, 49; ovalis 34, 36, 37, 42, 44; ovata 34, 36, 40, 41, 45, 49; tomentosa 34, 37, 38, 48

Cassandra calyculata, var. angustifolia 320

Cassia deeringiana 390; fasciculata 136; nicitans 158

Cedrela odorata 417

Cenchrus gracillimus 412

Ceramium daviesii 81, 550; diaphanum 276; fastigiatum 276; rubriforme 277; rubrum 277; secundatum 94, 575; strictum 278; violaceum 537

Cerastium vulgatum 317

Chaetomorpha area 266; linum 266

Chamaesaracha boliviensis 364; coniodes 326, 328, 329, 334, 339, 341, 355, 357, 359, 360, 362; coronopus 326-328, 334, 337-342, 345, 349; crenata 326, 328, 331, 334, 338, 351-354; echinata 364; edwardsiana 328, 334, 339, 341, 344, 345, 347-349; grandiflora 364; heterophylla 364; japonica 364; nana 364; pallida 326, 328, 334, 339, 345-349, 355; physaloides 364; potosina 364; savatieri 364; sinensis 364; (Solanaceae), Biosystematic Study of 325; sordida 326-328, 334, 339, 347, 353, 355, 356, 358; villosa 328, 334, 338, 349, 350, 351, 353, 354; watanabei 364

Champia parvula 275

Chantransia alariae 541; attenuata 583; catenulata 86, 557; collopoda 86, 557; corymbifera 88, 551, 556, 563; crassipes 86, 558; dasyae 545; daviesii 81, 550, 577; dufourii 84, 85; efflorescens 584; var. thuretii 88, 55, 556, 560, 563; emergens 92, 572, 574, 605, 611; endozoica 92; flexuosum 532, 577, 582; hallandica 84; humilis 569; infestans 91; luxurians 94, 575; macounii 549; microscopica 86, 557; minima 572; moniliformis 87, 558; parvula 85; polyides 587; rhipidandra 541, 544, 609; sagraeana 551, 560, 577, 591; sargassi 84; saviana 560; secundatum 94, 541, 545, 558, 575, 580; tenuissima 576; thuretii 88, 560, 562; unilateralis 544; virgatula 94, 541, 545, 560, 576, 580; var. luxurians 576; f. tenuissima 576, 581

Chasmanthium nitidum 369

Chenopodium album 317

Chesapeake Bay Area, The Marine Algae of Virginia and Maryland, Including the 258
Chimaphila maculata 162-164; (L.) Pursh in Maine and New Hampshire 162
Chinnappa, C. C. see Gill, L. S.
Chiogenes hispidula 320
Chlorella 265
Chondria baileyana 280; sedifolia 280; tenuissima 280
Chondrus crispus 275
Choris floridana 370
Chromastrum alariae 541; collopodum 86, 557; compactum 86, 557; crassipes 87, 558; hallandicum 84; humile 569; infestans 91; microscopicum 86, 557; moniliforme 87, 558; rhipidandra 541; secundatum 94, 575; unifilum 564; virgatulum 94, 576
Chromosome Pairing in Obligately Apogamous Ferns; Pellaea atropurpurea and Pellaea glabella, var. glabella 122
Chroococcus turgidus 283
Chrysanthemum leucanthemum, var. pinnatifidum 321
Cienfuegosia heterophylla 418; yucatanensis 418
Cinna arundinacea 315; latifolia 315
Circaea alpina 319
Cirsium arvense 321; vulgare 321
Citrus aurantium 417
Cladophora albida 266; crystallina 266; expansa 266; fascicularis 266; flexuosa 267; var. densa 267; gracilis 267; magdalenae 267; rupestris 267; sagraena 590
Clematis dioscoreifolia 158, 159; var. robusta 158
Clerodendrum speciosissimum 421
Closterium gracile 261
Coccochloris elabens 283; peniocystis 283; stagnina 283
Coccothrinax argentata 414; inaguensis 414
Coelopleurum lucidum 319
Colaconema americana 574, 588, 589, 608, 611; bonnemaisoniae 94, 566; humilis 534, 569-571, 583, 604, 607; **infestans** 79, 80, 89, 90 fig., 92, 94; **membranacea** 534, 556, 568, 569, 590, 603, 608; **minima** 534, 572-574, 588, 589, 605, 607, 611; nakamurai 564; polyides 587; porphyrae 92
Colaconema **secundata** 79, 81, 93-97, 532, 533, 555, 556, 575, 579, 581, 582, 591, 592, 606-608; tenuissima 576
Collinsonia canadensis 400
Colobanthus kerguelensis 240
Colt, L. C., Jr. and Steven Swartz An Unusual Substrate for Polysiphonia paniculata Montagne 488
Colubrina asiatica, var. asiatica 418
Conchocelis rosea 608
Conferva daviesii 81, 550; purpurea 536; rothii 537; rupestris 95; violacea 537
Conopholis americana 167
Convolvulus sepium 320; f. malachophyllus 320
Conyza bonariensis 406
Coptis groenlandica 318
Corculum leptopus 386
Cornus amomum, ssp. microcarpa 396; canadensis 319; purpusii 396
Cotula plumosa 241
Crotalaria lanceolata 391
Croton alabamensis 371; discolor 417; linearis 417
Cuphaea carthaginensis 393
Cyathea weatherbyana 144
Cymophyllum fraseri 252, 253

Cynanchum graminifoium 420
Cyperus aristata 413; dentatus 379; difformis 379; globosus 414; globulosus 414
Cypripedium calceolus 491; ssp. parviflorum 491; From Alaska, New Record for the Yellow Lady's Slipper Orchid 491; guttatum 491; passerinum 491
Cystopteris fragilis 239

Danthonia spicata 315
Dasya pedicillata 279
Delphinium virescens 136
Dennstaedtia punctilobula 315
Dentaria laciniata 158, 160
Deschampsia flexuosa 315, 371
Desmanthus illinoensis 136
Desmotrichum undulatum 270
Dianthus prolifer 387
Diarina festucoides 369
Diarrhena americana 369
Dicentra canadensis 158, 161
Dichothrix penicillata 292
Dichromena colorata 379; latifolia 380
Dictyosiphon foeniculaceus 270
Digitalis lutea 159
Diodia hirsuta 403
Dioscorea bulbifera 414
Diplotaxis muralis 388
Distichlis spicata 57
Drosera rotundifolia 318
Dryopteris cristata 314; Goldiana 167; spinulosa, var. americana 314
Drysdale, Frank R. Variations of Seed Size in Atriplex patula, var. hastata (L.) Gray 106

Eastman, Lesley M. Some New Locals in the Maine Flora 166; see also Hodgdon, A. R.
Echinocephalum latifolium 173, 180
Ectocarpus confervoides 58, 260; elachistaeformis 268; penicillatus 268; siliculosis 268
Eichornia crassipes 486, 487; subovata 478
Elachistea fucicola 58, 62, 269
Eleocharis acicularis 57; elliptica 315; flavescens 377; geniculata 414; halophila 315; melanocarpa 376; olivacea 377; robbinsii 377; smallii, var. major 315; tricostata 377; wolfii 378
Elephantopus cuneifolius 184
Elymus arenarius, var. villosa 315; virginicus 315
Emilia javanica 423; sonchifolia 423
Empetrum nigrum 319
Enteromorpha erecta 58, 60, 62, 263; clathrata 262; compressa 262; groenlandica 58, 60; intestinalis 58, 263; lingulata 263; linza 58, 263; marginata 264; micrococca 264; minima 264; plumosa 264; prolifera 264
Entocladia viridis 261; wittrockii 262
Entophysalis conferta 284; deusta 284
Epilobium angustifolium 319; ciliatum 394; glandulosum, var. adenocaulon 319
Epipactis Helleborine 166
Equisetum arvense, var. boreale 313; sylvaticum, var. pauciramosum 313
Eragrostis amabilis 369; ciliaris 413; var. laxa 412; excelsa 412; urbaniana 413
Erigeron L. (Compositae), A New Alaskan Species of 116
Erigeron grandiflorus 116, 118, 119; **Hultenii 116-119**; hyperboreus 118; Muirii 118; myrionactis 406; peregrinus 118, 119; repens 406; simplex 118; uniflorus, ssp. eriocephalus 118

Eriocaulon lineare 369, 382; texense 383
Eriophorum angustifolium 315; spissum 315; virginicum 315
Erythroclada subintegra 272
Erythrotrichia rhizoides 272
Euphrasia americana 320; randii 320

Faasen, Paul Van Chromosome Numbers in Asters 26
Fantz, Paul R. see Lewis, Walter H.
Faust, W. Z and S. B. Jones, Jr. The Systematic Value of Trichome Complements in a North American Group of Vernonia (Compositae) 517
Festuca myuros 369; rubra, var. rubra 314
Filipendula ulmaria 318
Fimbristylis annua 414; autumnalis 414; perpusilla 378, 379; puberula 368
Flaveria bidentis 422; trinervia 422
Forestiera ligustrina 135
Fosliella farinosa 274; lejoisii 274
Fothergilla major 389
Fragaria virginiana 318
Fralick, Richard A. see Mathieson, A. C.
Fremyella grisea 293
Fucus vesiculosis 58, 262, 269, 270; var. sphaerocarpus 271; var. spiralis 58, 60
Fuirena pumila 376

Gaillardia pulchella 422
Galapagos Islands, Flora of (Review) 140
Galeopsis tetrahit, var. bifida 320
Galium trifidum 321
Gelidium crinale 274
Geranium robertianum 392
Geum laciniatum 390
Giffordia duchassaiginiana 268
Gilia achilleaefolia, ssp. achilleaefolia 235; ssp. multicaulis 235
Gill, L. S. and C. C. Chinnappa A Note on the Karyology of Haplopappus spinulosus (Pursch) DC., ssp. typicus Hall 220
Gillis, Wm. T., Richard A. Howard and George R. Proctor Additions to the Bahama Flora Since Britton and Millspaugh 411
Glandularia drummondii 400
Glaux maritima 320
Gnaphalium uliginosum 321
Gomontia polyrhiza 265
Gomphosphaeria aponina 283; lacustris 284
Goniotrichum alsidii 271
Goodyera repens, var. ophioides 316
Gracilaria foliifera 274; verrucosa 275
Grand Manan, New Brunswick, The Vascular Flora of Kent Island 311
Grania efflorescens 584
Griffithsia tenuis 278
Grinnelia americana 262, 280
Guilandina divergens 416
Gutierrezia dracunculoides 404
Gyrotheca tinctoria 385

Habeneria Hookeri 166; obtusata 316
Haplopappus spinulosus, ssp. cotula 221; ssp. spinulosa 224; ss. typicus 220, 221, 223; A Note on the Karyology of 220
Harms, Vernon L. New Record for the Yellow Lady's Slipper Orchid, Cypripedium calceolus L., ssp. parviflorum (Salisb.) Hult. From Alaska 491
Harrisia undata 419

Harvill, A. M., Jr. Phytogeography of the Carices of Virginia 248
Haynes, Robert R. and James L. Reveal A Re-evaluation of Potomageton fibrillosus Fern. (Potomagetonaceae) 75
Hedeoma drummondii 400
Hedyotis nigricans, var. filifolia 421
Helenium autumnale 136
Heracleum maximum 319
Heteranthera limosa 486, 487
Hibiscus acetosella 418
Hickories in New England, The Northern Limits of the Distribution of 34
Hieracium aurantiacum 322; floribundum 322; pilosella 322; pratense 322; umbellatum 159, 161; vulgatum 159
Hildenbrandia prototypus 59, 61
Hill, Michael L. and O. M. Rogers Chemical, Cytological and Genetic Evidence for the Hybrid Origin of Aster Blakei (Porter) House 1
Hippurus vulgaris 319
Hodgdon, A. R. Flora of the Galapagos Islands (Review) 140; The Genus Lesquerella (Cruciferae) in North America (Review) 622; and Lesley M. Eastman Chimaphila maculata (L.) Pursh. in Maine and New Hampshire 162; see also McClair, John; Steele, F. L.
Homalobus amblyodon 304
Hordeum jubatum 314
Howard, Richard A. A Partial History of the New England Botanical Club 493; see also Gillis, Wm. T.
Hudsonia tomentosa 56
Hydrocoleum holdenii 285
Hydrocotyle umbellata 420
Hypericum virginicum, var. fraseri 319
Hypnea musciformis 274
Hypochaeris glabra 409
Hypoxis juncea 385
Hyptis mutabilis 482

Impatiens capensis, f. immaculata 319
Ipomoea muricata 399; nil 420
Iris versicolor 316
Isnardia spathulata 394
Isoetes butleri 367, 368; melanopoda 367, 368
Isotria medeoloides 166, 167
Iva annua 407; ciliata 407; microcephala 406

Jasminum fluminense 420
Jones, S. B., Jr. see Faust, W. Z.
Juncus brachycephalus 384; brevicaudatus 316; bufonius 316; var. halophilus 316; effusus, var. compactum 316; filiformis 316; gerardi 57, 316; nodatus 384; roemerianus 414; tenuis 316
Juniperus communis, var. depressa 314

Kalmia angustifolia 320
Kerguelen Islands, Palynological Evidence for the Late Glacial Occurrence of Pringlea and Lyallia on 239
Kiang, Y. T. Floral Structure, Hybridization and Evolutionary Relationship of Two Species of Mimulus 225
Kowal, Robert R. and T. M. Barkley Senecio anonymous Wood, An Earlier Name for Senecio smallii Britton 211
Kral, Robert Some Notes on the Flora of the Southern States,

Particularly Alabama and Middle Tennessee 366
Kylinia alariae 541, 608; australis 564; catenulata 86, 557; collopoda 86, 557; compacta 86, 557, 608; crassipes 87, 558; cytophaga 592; dufourii 84; hallandica 84, 608; humile 569; infestans 91; microscopica 86, 557; moniliformis 87, 558, 608; rhipidandra 541; secundata 94, 575, 608; sargassi 84; unifila 564, 608; virgatula 94, 576, 608; f. luxurians 576

Lachnanthes caroliniana 382, 385
Lachnocaulon digynum 383; engleri 383; minus 369, 384
Laciniaria chapmanii 404
Lactuca saligna 410
Laguncularia racemosa 103, 105
Laminaria digitata 58; saccharina 59
Larix laricina 314
Lathyrus japonicus 319
Leathesia difformis 269
Ledum groenlandicum 320
Leontodon autumnalis, var. pratensis 321
Lepidium filicaule 416; virginicum 416
Leptilon bonariense 406
Leptochloa fascicularis 370; uninervia 370
Lesquerella (Cruciferae) in North America, The Genus (Review) 622
Leticula resupinata 403
Leucophysalis grandiflora 332, 364; heterophylla 364; nana 364
Lewis, Walter H. and Paul R. Fantz Tribal Classification of Triosteum (Caprifoliaceae) 120
Liagorophila endophytica 574
Liatris chapmanii 404
Ligusticum scothicum 319
Limonium carolinianum 53, 56; nashii 320
Lindernia crustacea 403
Linnaea borealis, var. americana 321
Linum westii 392
Listera cordata 316
Lobelia Kalmii 160
Lomentaria baileyana 276
Lonchocarpus sericeus 416
Lonicera canadensis 321
Lowden, Richard M. Revision of the Genus Pontederia L. 426
Ludwigia spathulata 394; sphaerocarpa 395; suffruticosa 395
Luzula multiflora 316
Lyallia kerguelensis 241, 243; on Kerguelen Islands, Palynological Evidence for the Late Glacial Occurrence of Pringlea and 239
Lycopodium alopecuroides 368; annotinum, var. acrifolium 313; clavatum 144, 256; lucidulum 256; obscurum, f. dendroideum 313; prostratum 368
Lycopus uniflorus 320; virginicus 320
Lyngbya 60; aerugineo-coerula 285; aestuarii 285; confervoides 285; gracilis 285; lutea 285; semiplena 286
Lysimachia gramineum 397; lanceolata 398; quadrifolia 398; terrestris 320
Lythrum salicaria 56

Maianthemum canadense 316
Maine Flora, Some New Locals in the 166
Maine and New Hampshire, Chimaphila maculata (L.) Pursh in 162
Manisuris rugosa 374; tuberculosa 374

Manning, Wayne E. The Northern Limits of the Distribution of Hickories in New England 34
Marshallia mohrii 368, 408
Maryland, Including the Chesapeake Bay Area, The Marine Algae of Virginia and 258
Mastigocoleus 293
Mathieson, A. C. and Richard A. Fralick Benthic Algae and Vascular Plants of the Lower Merrimack River and Adjacent Shoreline 52
Matricaria maritima, var. agrestis 321; matricarioides 321
Maytenus buxifolia 418; phyllanthoides 418
McCain, John, R. B. Pike and A. R. Hodgdon The Vascular Flora of Kent Island, Grand Manan, New Brunswick 311
Medicago minima 391; orbicularis 391
Melanthera amethystina 192; angustifolia 172, 174, 176-179, 181, 183, 187, 197-199, 202, 206; var. subhastata 198; aspera 169, 171, 177, 180, 181, 188, 190, 192, 206; var. aspera 174, 176, 177, 182, 184, 187, 188, 190, 192, 193; var. glabriuscula 171, 173, 174, 176, 177, 181, 182, 184, 187, 194, 195, 207; brevifolia 194; buchii 192; calcicola 194; canescens 192; carpenteri 184; (Compositae), A Revision of North American and Caribbean 169; confusa 194; corymbosa 192; crenata 194; deltoidea 192; fruticosa 206; hastata 171, 184, 186, 188; ssp. cubensis 193; var. cubensis 192; var. lobata 184; var. pandurata 184; var. parvifolia 200; hastifolia 206; lanceolata 198, 199; ligulata 172, 174, 176, 177, 180, 183, 187, 199, 203-205; linearis 177, 198; Linnaei 192; lobata 184; microphylla 198; molliuscula 192; montana 193; nivea 170, 171, 173, 174, 176, 177, 180, 183-188, 199, 205-207; oxycarpha 184; oxylepis 184, 188; panduriformis 171, 184; parviceps 206, 207; parvifolia 172, 174, 176-180, 182, 187, 199-201; purpurascens 198, 199; radiata 179, 200; trilobata 184; urticifolia 192
Melica nitens 371
Meliotus alba 416
Melosira 59
Menyanthes trifoliata, var. minor 320
Merismopedia 60; glauca 284
Merremia tuberosa 420
Merrimack River and Adjacent Shoreline, Benthic Marine Algae and Vascular Plants of the Lower 52
Mertensia maritima 320
Mesadenia diversifolia 409
Metastelma graminifolium 420
Miconia Robinsoniana 144
Microcoleus chthonoplastes 286; lyngbyaceus 287; tenerrimus 287; vaginatus 287
Micromenia bahamensis 421; brownei 421
Mimulus, Floral Structure, Hybridization and Evolutionary Relationship of Two Species of 225; guttatus 225-237; nasutus 225-237
Mirabilis longiflora 235; nyctaginea 161
Monanthochloë littoralis 413
Monarda clinopodia 482
Moneses uniflora 319
Monochoria hastata 431

Monostroma leptodermum 262; oxyspermum 58, 60, 262
Monotropa hypopithys 320; uniflora 319
Morinda citrifolia 421
Morrow, Loring and Norton H. Nickerson Salt Concentrations in Ground Waters Beneath Rhizophora mangle and Avicennia germinans 102
Mosla dianthera 401
Muhlenbergia frondosa 372; glabriflora 371
Myrica gale 316
Myrionema strangulans 269
Myriotrichia subcorymbosa 269
Myriophyllum exalbescens 395; heterophyllum 115; pinnatum 115

Najas marina 412
Narukila cordata 454; var. lancifolia 454, 562
Nemalion multifidum 273
New Brunswick, The Vascular Flora of Kent Island, Grand Manan 311
New England, The Northern Limits of the Distribution of Hickories in 34
New Hampshire, Chimaphila maculata (L.) Pursh in Maine and 162; Plants, New or Noteworthy 158; Two Interesting Plants on Mt. Cardigan, Orange, 155
Nickerson, Norton H. and Joseph W. Tripp Floral Dimorphism in Rachicallis americana (Jacq.) Hitch. (Saltwater Bush) 111; see also Morrow, Levring
Nodularia harveyana 292
Nuphar luteum 68; microphyllum 65-71, 73; Some Morphological Aids in Distinguishing From Similar Aquatics 65; X rubrodiscum 66-68, 70, 73; variegatum 66-70
Nymphoides cordata 65, 70-73

Oenothera perennis 319
Onoclea sensibilis 313
Oscillatoria 60; amphibia 287; brevis, var. neapolitana 287; laetevirens 287; lutea 288; margaritifera 288; nigro-viridis 288; princeps 288; retzii 288; salinarum 288; splendida 289; submembranaceae 289; subuliformis 289
Osmunda cinnamomea 313
Ott, Franklyn D. The Marine Algae of Virginia and Maryland, Including the Chesapeake Bay Area 258
Oxalis montana 319
Oxopolis filiformis 420

Panax quinquefolium 167
Panicum adspersum 373; amarum 373; capillare 136; echinulatum 413; linearifolium 373, 374; malacophyllum 373; rigidulum 166; webberianum 373; werneri 374
Parks, James C. A Revision of North American and Caribbean Melanthera (Compositae) 169
Paspalum bakeri 413; laxum 413, minus 372; molle 413; propinquum 413; urvillei 413; vaginatum 372
Pediastrum boryanum 266; duplex 266; simplex 266
Pellaea atropurpurea 122-125, 127-130; And Pellaea glabella, var. glabella, Chromosome Pairing in Obligately Apogamous Ferns 122; glabella 122; var. glabella 123, 124, 126-130; var. occidentalis 129
Percursaria percursa 264

Pernettya Howellii 142
Persicarria bicornis 386
Petalonia fascia 59, 62, 270
Petalostemon foliosus 132-138; The Past and Present Geographical Distribution of, and Notes on Its Ecology 132
Philactis Liebmannii 206
Phleum pratense 315
Phlox divaricata 397; pilosa, var. ozarkana 400
Phoenix dactylifera 414
Phormidium persicinum 289; retzii 289; submembranaceum 289; unciniatum 289; weissi 289
Physaliastrum japonicum 364; savatieri 364
Physalis lobata 333; 364; longifolia 402; sinensis 364; subglabrata 402; wrightii 333
Phytolacca purpurascens 415
Picea glauca 314; mariana 314; rubens 3
Pike, R. B. see McCain, John
Pilaiella littoralis 59
Pinus elliotti 177
Piriqueta caroliniana 419; tomentosa 419; viridis 419
Pisonia floribunda 143
Plantago hookeriana 403; juncoides 56; var. decipiens 320; var. glauca 321; major 320; oliganthos 56, 321; patagonia 403; virginica 421; wrightiana 403
Plectonema calothricoides 293; golenkinianum 293; tenebrans 293
Poa annua 314; compressa 314; Cookii 240; kerguelensis 240; palustris 314; pratensis 314
Poinsettia cyathophora 417, 418; heterophylla 418
Polanisia dodecandra 389
Polygonella fimbriata 386
Polygonum allocarpum 317; amphibium 317; erectum 386; hydropiper 57; hydropiperoides 317; lapathifolium 317; longistylum 386
Polysiphonia denudata 280; fibrillosa 59, 60; harveyi 281; nigrescens 281; novae-angliae 282; paniculata 488, 490; An Unusual Substrate For 488; subtillissima 282; urceolata 282
Pontederia angustifolia 452-454; brasiliensis 473; caerulea 453; cordata 426-429, 431, 433, 435, 443, 445, 447, 448, 450, 452-454, 460; f. albiflora 454; f. angustifolia 453, 454, 462; f. bernardi 455; f. brasiliensis 453, 454; f. latifolia 454; f. sagittata 467; f. taenia 455; var. albiflora 453; var. angustifolia 452; var. cordata 430, 436, 442, 446, 450-452, 456-458, 460, 464, 466, 484, 486, 487; var. lanceolata 462; var. lancifolia 436, 445, 446, 450, 454, 457, 458, 460, 461, 464, 467, 486, 487; var. ovalis 436, 445, 446, 450, 461, 464, 466, 486, 487; var. parviflora 471; var. sagittata 467; var. typica 453, 462; cordifolia 473; eriantha 473; hastata 427-429, 431; heterantherimorpha 462; L., Revision of the Genus 426; lagoënsis 478; lanceolata 462; f. brasiliensis 454; f. ovalis 466; f. trullifolia 454; var. vichadensis 466; lancifolia 460-462; nymphaeifolia 453; oblonga 462; ovalis 461, 466; ovata 427, 428; parviflora 430, 432, 434, 435, 437, 439, 441, 445, 446, 450, 469, 471-473, 484, 486, 487; reniformis 473; rotundifolia 430, 432-435, 438, 439, 441-443, 445, 446, 450, 473, 474, 476, 480, 484, 486, 487; var. nym-

phaeifolia 454; sagittata 430, 434, 435, 437, 445-447, 450, 460, 467-469, 478, 484, 487; schomburgkiana 478; **subovata** 435, 438, 443, 449, 450, 478-480
Porphyra leucosticta 59, 60, 62, 272; miniata 272; umbilicalis 59, 272
Porphyrosiphon notarisii 289; **splendidus 290**
Potamogeton fibrillosus 75, 76; A Re-evaluation of 75; foliosus 75, 76; var. **fibrillosus** 76, 77; var. foliosus 77
Potentilla anserina 318; egedei, var. groenlandica 57; norvegica 318, 390; tridentata 155
Psidium galapageium 143
Pseudendoclonium marinum 58, 61, 262
Pteridium aquilinum 144
Pteris vittata 412
Ptilimnium costatum 395
Ptilota serrata 59, 60, 62
Pucciniellia paupercula, var. alaskana 314
Punctaria latifolia 270; plantaginea 270
Pylaiella littoralis 268
Pyrus americana 318; decora 318; floribunda 318; malus 318
Pringle Herbarium, The 297
Pringlea and Lyallia on Kerguelen Islands, Palynological Evidence for the Late Glacial Occurrence of 239
Pringlea antiscorbutica 241, 242
Proctor, George R. see Gillis, Wm. T.
Protoderma marinum 262

Rachicallis americana 111-113; (Saltwater Bush), Floral Dimorphism in 111
Ralfsia verrucosa 59
Ramalina calicaris, f. pyrifera 307, 308; var. subamplicata 306, 307; f. subpapillosa 307, 308; canariensis 307; fastigiata, var. subampliata 306, 307; subampliata 306, 307, 309; (Nyl.) Fink in North America, The Status of 306
Ramium niveum 386
Ranunculus 57; acris 318; cymbalaria 318; Mosleyi 240
Ratibida columnaris 407; columnifera 407
Reimarochloa oligostachya 372
Reussia grazielae 474; lagoënsis 478; rotundifolia 474; subovata 478; **triflora** 449, 473, 478
Reveal, James L. see Robert R. Haynes
Reviews 114, 140, 323, 622
Rheum rhaponticum 317
Rhexia mariana 394; var. mariana 394; salicifolia 369, 394; virginica 394
Rhinanthes crista-galli, var. fallax 320
Rhizoclonium kockianum 267; riparium 58, 269; tortuosum 267
Rhizophora mangle 102-105; And Avicennia germinans, Salt Concentrations in Ground Waters Beneath 102
Rhodochorton amphiroae 551, 555; attenuatum 583; catenulatum 86, 551; concrescens 568; daviesii 81, 551; efflorescens 584; emergens 572; endophyticum 574; entozoicum 589, 590, 698; hallandicum 84; humile 569; infestans 91; intermedium 536; islandicum 536, 540; membranaceum 91, 94, 566; mesocarpum, var. penicilliformis 585; microscopicum 86, 557; moniliforme 87, 558; parasiticum 536, 540; penetrale 92;

penicilliforme 585, 586, 603, 608; purpureum 530, 536, 540, 608; rhipidandra 541; Rothii 540; spetsbergense 585; subsimplex 576; tenue 537, 540; tenuissimum 576, 581; thuretii 88, 560; virgatulum 94, 577
Rhododendron austrinum 396, 397; calendulaceum 396; canadense 320; canescens 397; maximum 163
Rhus aromatica 135
Rhyncheletrum repens 413; roseum 413
Rhynchospora capillacea 161; fernaldii 380; perplexa 368; pleiantha 380
Ribes glandulosum 318; hirtellum 318; lacustre 318
Rigby, Sylvia Jane Chromosome Pairing in Obligately Apogamous Ferns; Pellaea atropurpurea and Pellaea glabella, var. glabella 122
Rivularia nitida 293
Rogers, O. M. see Hill, L. Michael
Rorippa islandica, var. fernaldiana 318; var. hispida 318
Rosa rugosa 318
Rotala ramosier 422
Rubus chamaemorus 318; hispidus 318; idaeus, var. canadensis 318
Rudbeckia hirta 136, 407; mollis 407; triloba 136
Rumex acetosella 317; domesticus 317; fenestratus 317; orbiculatus 317; pallidus 317
Rundel, Phillip W. see Bowler, Peter A.
Ruppia maritima 142

Sabatia difformis 398; paniculata 398; quadrangula 398; stellaris 420
Sagina procumbens 317
Sagittaria isoetiformis 368
Salicornia europaea 53, 54, 56, 317
Salix amygdaloides 158, 161; rigida 385
Sanguisorba canadensis 256
Saracha coronopus 339; potosina 364
Sargasso Sea, The Audouinella Complex (Rhodophyta) in the Western 78
Sargassum fluitans, 79, 95; hystrix 271; natans 79, 84, 89, 95, 271
Sarracenia purpurea 318
Satureja rigida 421
Saxifraga rivularis 153, 154; In the White Mountains, New Hampshire, A New Station For 153
Scenedesmus acuminatus 266; opaliensis 266; quadricauda 266
Schistostega osmundacea 149; pennati 149; The Environment of, New Vermont Stations 149
Schizothrix arenaria 290; calcicola 290; tenerrima 290
Schoenolirion croceum 368
Schofield, Eileen K. see Young, Steven B.
Scirpus americanus 315; atrocinctus 315; atrovirens 315; cyperinus 315: debilis 376; maritimus 54, 61; var. fernaldi 57; purshianus 376; validus 54, 57, 61
Scutellaria epilobiifolia 320; racemosa 401
Scytosiphon lomentaria 59, 270
Sedum roseum 318; telephium, f. purpureum 318
Senecio anonymus 211-214, 216-218; An Earlier Name For Senecio smallii Britton 211; aureus, var. angustifolius 217; confusus 423; earlei 219; smallii 211, 212, 214, 216, 217;

f. tristis 219; sylvaticus 321; tomentosus 211, 214, 216-218; vulgaris 321
Sesuvium microphyllum 415
Setaria geniculata 413; faberi 372
Seymour, Frank C. The Pringle Herbarium 297
Sida elliottii 393
Silene gallica 387
Sisyrinchium exile 415; micranthum 415; montanum, var. crebrum 316
Sium suave 57
Smilax dominguensis 414; havanensis 414
Smilacina stellata, var. crassa 316; trifolia 316
Solanum eleagnifolium 421; chamaesarachidium 364; conioides 359; coronopus 339
Solidago elliotti 405; graminifolia, var. nuttallii 321; macrophylla 321; odora 160; rugosa, var. villosa 321; sempervirens 53, 54, 56, 321, 423; sempervirens, var. mexicana 423; uliginosa 405
Sonchus asper 322
Sorghum halepense 413
Sparganium americanum 314
Spartina alterniflora 53, 54, 56, 61, 315; patens 53, 54, 56, 61; spartinae 370
Spathelia bahamensis 417
Spergularia canadensis 317; marina 57, 317; rubra 317
Spermacoce aspera 422
Spermolepis inermis 395; patens 395
Spiraea latifolia 318
Spiranthes lucida 158, 160; romanzoffiana 316
Spirogyra 261
Spirulina major 290; subsalsa 291; f. oceanica 291; tenerrima 291
Sphacelaria fusca 268
Spondias purpurea 418
Spongberg, Stephen A. A New Alaskan Species of Erigeron L. (Compositae) 116
Spongomorpha arcta 58, 60, 62
Sporobolus vaginiflorus 135
Spyridia filamentosa 278
Stachys floridana 401; hispida 401
Stanford, Jack W. Umaldy T. Waterfall (1910-1971) 146
Staurastrum 261
Steele, F. L. and A. R. Hodgdon Two Interesting Plants on Mt. Cardigan, Orange, New Hampshire 155
Steironema gramineum 397, quadriflorum 398
Stellaria calycantha, var. isophylla 317; graminea 317; humifusa 317; media 317
Stenandrium carolinae 422
Stenophyllum capillaris 378
Sterk, Fern Frank see Van Fassen, Paul
Stilophora rhizoides 269
Streptopus amplexifolius, var. americanus 316
Striaria attenuata 269
Stylosanthes calcicola 416; tuberculata 416
Suaeda americana 317; maritima 317
Svida microcarpa 396
Swartz, Steven see Colt, L. C., Jr.
Symphoriocarpos orbiculatus 135
Symploca atlantica 291

Talinum triangulare 415
Tanacetum vulgare 321
Taraxacum erythrospermum 410; laevigatum 410; officinale 322
Tennessee, Some Notes on the

Flora of the Southern States, Particularly Alabama and Middle 366
Terminalia muelleri 419
Thalictrum debile 387; dioicum 388; macrostylum 388; mirabile 387; polygamum 318; texanum 388
Thamnidium intermedium 536, 540; mesocarpum, f. penicilliformis 585, 587; rothii 537; spetsbergense 585, 587
Thelypteris palustris, var. pubescens 314
Thermopsis villosa 159
Thysanella fimbriata 386
Tiffney, Wesley N., Jr. A New Station for Saxifraga rivularis L. in the White Mountains, New Hampshire 153
Tofieldia glutinosa 160
Trailliella intricata 273, 279
Trentopohlia daviesii 81, 551, 577; purpurea 536; virgatula 95, 577; var. secundata 577
Trichodesmium thiebautii 291
Trientalis borealis 320
Trifolium angustifolium 391; agrarium 319; pratense, var. sativum 318; repens 319; vesiculosum 391
Triglochin maritima 56, 314; palustre 314
Triosteum (Caprifoliaceae), Tribal Classification of 120; perfoliatum 121
Trismeria trifoliata 412
Tryon, Rolla Aquatic and Wetland Plants of the Southwestern United States (Review) 114
Tunica prolifera 387
Typha latifolia 57, 314

Ulothrix endosporangia 261; flacca 58, 261; subflaccida 261
Ulva lactuca 58, 63, 364; var. latissima 265; var. rigida 265
Uniola nitida 369
Unisema acutifolia 453; cordata 454; f. angustifolia 454; f. latifolia 454; deltifolia 452; heterophylla 453; var. lanceolata 453; var. stenocardia 453; lancifolia 462; f. trullifolia 454; latifolia 452; var. albiflora 453; var. elatior 453; var. pallida 453; var. undulata 453; media 452; var. albiflora 452, 454; mucronata 452; obliquata 452; obtusifolia 452; orbiculata 473; peduncularis 453; var. parviflora 453; purshiana 452; rotundifolia 453; sagitata 452
Urospora penicilliformis 58
Urtica procera 317; viridis 317
Utricularia resupinata 403

Vaccinium angustifolium, var. laevifolium 320; oxycoccus 320; var. ovalifolium 320; vitis-idaea, var. minus 320
Valeriana pauciflora 404
Van Fassen, Paul and Fern Frank Sterk Chromosome Numbers in Aster 26
Vaucheria 59-62
Verbena bipinnatifida 400
Vermont, New Stations (and) The Environment of Schistostega pennati (Hedw.) Hook & Tayl. 149
Vernonia acaulis 519, 523, 525; angustifolia 519, 523-525, arkansana 519, 523-525; baldwinii 525; ssp. baldwinii 519, 520, 523, 526, 527; ssp. interior 519, 520, 523, 526; blodgettii 519, 523, 525, 526; The Systematic Value of Trichome Complements in a North American Group of 517; ervendbergii 519,

523-525; fasciculata 519, 522-525; flaccidifolia 519, 522, 523, 525; gigantea 519, 523-525; glauca 519, 525; greggii 519, 523-525; interior 525; larsenii 519, 522, 523, 525; lettermannii 519, 523, 525; lindheimeri 519, 522, 523, 525; marginata 519, 520, 522, 523, 525; missurica 519, 520, 523, 525, 526; noveboracensis 519, 523-525; pulchella 519, 523, 525; shaffneri 519, 523-525; texana 519, 523-525
Veronica anagallis-aquatica 482
Vicia cracca 319
Viguirea porteri 408
Viola cucullata 319; pallens 319; septentrionalis 319
Virginia and Maryland, Including the Chesapeake Bay Area, The Marine Algae of 258
Virginia, Phytogeography of the Carices of 248
Vitis munsoniana 393

Warea amplexifolia 389; cuneifolia 389; sessilifolia 389
Waterfall, Umaldy T. (1910-1971) 146
Wicks, Johonet C. Some Morphological Aids in Distinguishing Nuphar microphyllum from Similar Aquatics 65
Withania sordida 355
Woelkerling, Wm. J. The Audouinella Complex (Rhodophyta) in the Western Sargasso Sea 78; The Morphology and Systematics of the Audouinella Complex (Acrochaetiaceae, Rhodophyta) in the Northeastern United States 529

Xanthocephalum dracunculoides 404
Xyris difformis, var. floridana 381; fimbriata 381, 382; iridifolia 382; jupicai 382; longisepala 369, 382; platylepis 382; smalliana 382

Young, Steven B. and Eileen K. Schofield Palynological Evidence for the Late Glacial Occurrence of Pringlea and Lyallia on Kerguelen Islands 239
Youngia japonica 423

Zanthoxylem bifoliatum 417
Zizania aquatica 54, 57, 61
Zostera marina 488; var. stenophylla 314

Missouri Botanical Garden Library
3 1753 00343 1282

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

Title of Publication: RHODORA

Date of Filing: October 22, 1973

Frequency of Issue: Quarterly

Location of Known Office of Publication:
Botanical Museum, Harvard University, Oxford Street,
Cambridge, Mass. 02138

Location of the Headquarters of the Publishers:
Botanical Museum, Harvard University, Oxford Street,
Cambridge, Mass. 02138

Publisher:
New England Botanical Club, Inc., Botanical Museum,
Harvard University, Cambridge, Mass. 02138

Editor:
Dr. Albion Hodgdon, Dept. Botany,
University of New Hampshire, N.H. 03824

Managing Editor:
Dr. Herman R. Sweet, Botanical Museum,
Harvard University Cambridge, Mass. 02138

Owner: New England Botanical Club, Inc., Botanical Museum, Oxford Street, Cambridge, Mass. 02138

No stockholders

Known Bondholders, Mortgagees, and other Security Holders: None

	Average No. Copies each issue during preceding 12 months	Single issue nearest to filing date
Total No. copies printed	850	850
Paid Circulation		
Sales through dealers, etc.	none	none
Mail subscriptions	782	792
Total paid circulation	782	792
Free distribution	12	12
Total distribution	794	804

I certify that the statements made by me above are correct and complete. Herman R. Sweet, Business Manager and Treasurer.